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Monday, April 18, 1864.

Lieutenant-Colonel T. ST. LEGER ALCOCK, in the Chair.

NAMES of MEMBERS who joined the Institution between the 4th and 18th April, 1864.

ANNUAL.

Douglas, Sir Robert, Bart., Capt., 57th Regt. 1*l.*
Holmes, H. R., Lieut., R.N. 1*l.*
Baldwin, G.W., Major, 20th Regt. 1*l.*
Scott, J. D., Colonel late Mad. Art. 1*l.*
Law, Robert, K. H., Major-General, Col. 2nd W. I. Regt. 1*l.*
Errington, A. J. Lieut., R.N. 1*l.*
Clayton, V. G., Lieut., Roy. Engrs. 1*l.*
Saumarez, Hon. James, Lieut., Grenadier Guards. 1*l.*

THE CONSTRUCTIVE SERVICE OF THE ARMY, OR MILITARY WORK BY MILITARY MEANS.

By Lieutenant-Colonel Millington H. Synge, R.E.

The Chairman: As the lecture which we are about to hear from Colonel Synge is likely to be followed by a discussion, I will take this opportunity of stating that as these discussions are of considerable importance, and interesting to members in every branch of the service, we are very anxious that our reports should be accurate. When gentlemen are kind enough to address the meeting, we can easily afford them the opportunity to correct the proofs; but we must pro-

vide against those corrections which amount to what is usually called a "*revise*," because a "*revise*" greatly increases the labour as well as the expense of publication. It likewise retards the appearance of the Journal, which is, to our absent members, a matter of regret. The subjects discussed at these meetings are usually those of the day, and absent members are anxious to hear the opinions of distinguished and experienced officers upon them. It is, therefore, a matter of much importance that our Journal should be issued at the proper time. Gentlemen are aware that we spare no trouble to conform to their wishes, but we are obliged to lay down this rule in consequence of the increased amount of labour occasioned by prolonged discussions, such as I hope we may be favoured with on the present occasion. I will now call upon Colonel Synge to commence his paper.

Colonel SYNGE: I. An army, to be perfectly equipped, ought to include *within its own constituent elements* a full provision for the supply of all its wants, and for the performance of all its duties.

The efficiency of an army is necessarily always in proportion to the completeness with which this provision is made and carried out.

The organisation *for* an army *must* make such provision, or failure at some stage is the inevitable result; but an army is incompletely and imperfectly equipped, if it does not include that provision *within its own organisation*.

II. Moreover, every arrangement made in connection with an army should be viewed in its relation to the primary object and paramount end of all armies, which is, fighting power.

III. Again, the arrangements should be confined, as strictly as is possible, to that which is essential. Whatever contributes to the essence of the army, in other words, whatever contributes to its fighting power, and is essential, should be provided, and nothing that does not.

Any provision made, or any arrangement introduced, that fails in this respect is necessarily injurious to the extent that it is made or introduced, but everything that does so contribute should be provided fully, and should be made available by an instrumentality as simple and as direct as possible.

IV. Every complex arrangement is in itself to be avoided, and bespeaks its own condemnation in its complexity.

Needless complication cannot be too strongly condemned.

Fighting power, the essence and object of armies, is determined by number and quality. These, therefore, should be the objects constantly in view, and no arrangement that fails both in increasing the number and in improving the efficiency of the army ought to be admitted.

The works required for the maintenance and by the duties of the army furnish preeminently an occasion when these maxims ought to be regarded in practice. The expenditure must, in any wise, be incurred, for the works must be supplied. If this be done by an instrumentality available as a combatant force, the same expenditure by which the works are supplied will besides both increase the numerical strength

and add to the efficiency of the army. Such would be, in every respect, the most economical means.

The whole strength of the army is not required to exceed that by which the duties for which it is wanted can be performed, and its own necessities supplied.

The constructive requirements are in like manner limited to those connected with the duties, or consequent upon the existence of the military force. It is clear, therefore, that the aggregate expenditure for military purposes is brought within the smallest possible compass, as well as most efficiently applied, when the same expenditure which supplies the constructive requirements, furnishes, also, in the act of doing so, a portion of the military force.

This may be briefly summed up in terms that carry conviction with them,

Military Work should be done by Military Means. Plainly, if the work that is now done by a body of men who are not available for military service were done by a like number that would be so available, the numerical strength of the combatant force would be increased to that extent.

So, also, to increase the efficiency of the units of which the aggregate of the army consists, is to increase the efficiency of that army as a whole; and to call into exercise the intelligence, resource, and physical energies of those units, is to increase their individual efficiency.

If officers and soldiers can plan the works and buildings required by their duties; if they can superintend the carrying them out; if they can execute those works, it may assuredly be affirmed, besides, that no other instrumentality can be so well cognisant of the true and actual nature of all military requirements; neither, in all probability, could those requirements be met at once so readily or so completely by any other instrumentality.

The combination of the structural and combatant functions is, if it be practicable, the perfect attainment of the end in view.

The chief practical aspects of *this* question are:—

First, from the military point of view, the effect upon the soldier of employment on military works.

Secondly, from the constructive point of view, the value of military labour in getting work done.

The soldier is affected (*a*) personally,
(*b*) in discipline, and
(*c*) in pay.

Can his employment on military works be combined with the necessary exercise and discipline of his calling and with economy? Will the receipt of greater earnings militate against his subordination and discipline? What will he do with the wages of his work?

The partial employment of military labour in the design, the superintendence and the execution of works, is an established custom. It takes place, to a greater or less extent, probably in every Service known, and the men so employed are conspicuous rather for higher than for inferior military bearing, proficiency, and character.

It is a question, therefore, of enlarged detail and practice, more

than of novelty of principle,—of the feasibility and probable results of extending the sphere of operations of a system, the effects of which can, in a great measure, either be stated from actual experience and fact, or accurately inferred from close analogy. It is not the suggestion of anything untried.

First, then, as to the soldier's individual efficiency and value.

Variety of occupation and active bodily employment bring into use all the different muscles of the frame, and thereby conduce not only to bodily health but to suppleness and usefulness, changing and correcting the somewhat stiffening tendencies on both mind and body of the habits into which the less intelligent and active men are but too apt to fall. Thus the sanitary condition of the cavalry is, as a rule, superior to that of the infantry, and this often, notwithstanding less favourable surroundings. The Royal Engineers have a less proportion of sickness among their numbers than the ordinary regiments of foot. The difference is so decided that it affects the mortality as well as the effective states of the several bodies. In other words, handling the currycomb and brush, or the use of the spade and pickaxe, and the employments of artificers and labourers, are beneficial to the health and longevity of the soldier. This is a matter of no little importance, when it is considered that a soldier of the line is estimated to have cost £60 before or by the time his training is complete.

Intelligence, which cannot fail to be developed by practical training in even the ruder kinds of skilled labour, more especially when the whole course of that training is directed towards supplying particular and personal requirements, is of great military value. The highest authority has affirmed that it is more effective than a great amount of drill towards perfecting the soldier as a marksman, in enabling him to chose and to adapt his position so as to place, use, and point his weapon to the best effect. It has been similarly determined that intelligence, activity, and the habit of exercising faculties of resource certainly best attain the important objects of light infantry movements, of which the execution depends upon the qualifications of each individual in these very particulars.

[Will you allow me to interrupt the lecture by a subject that probably may not arise in the discussion. When my paper was drawn up some years ago, it was based upon the experience in this respect of the previous Hythe practice. When that practice was first set down and tabulated, the Royal Engineers took a very high average. We have since very much fallen off, to the surprise of many of my brother officers; but I believe a simple explanation that has been suggested to me will meet the case, and I mention it here because I am not aware that it has ever been brought forward publicly before. Musketry instructors state that men of intelligence make the best marksmen; and the higher intelligence of the Royal Engineers probably made them better marksmen than the men of other regiments in the first instance. But other regiments are constantly practised in this one particular, and this constant practice would be altogether wasted, and fail in its object, if it did not at last give these regiments a higher relative position, putting out of consideration the fact that

the Royal Engineers are supplied with an arm of which the ammunition has now a different* windage. Quickness, intelligence, and education will tell; but when so much attention is devoted to one particular object, that is education in that matter, and it would be a melancholy reflection if no corresponding result were attained. If so, it might be argued, the less musketry drill we had, the better, which were going too far altogether, and I think the suggestion offered explains in a great measure the falling off of the Royal Engineers in their comparative standard and their figure of merit that has been noticed.]

In all these respects the soldier's efficiency and consequent value will have been increased; and so far as his abilities and general aptitude have been improved, he will have become more rather than less amenable to discipline. Neither will the *habits* of discipline deteriorate under a thorough and complete military organisation and system of carrying out the works. The maintenance of drill can be perfectly provided for by an adequate allotment of time specially determined.

In fact, the discipline of the soldier is only liable to be injuriously affected, if so liable at all, through the effect upon him of the receipt of wages for work done.

The classes of the army that under a military system of executing works would be in receipt of this increase would be, first, a proportion of those men by whom the works are executed at present as civilians, or others, of like standing and similar qualifications; and, secondly, a proportion of the existing army. With the attractions of permanent and fixed employment, and of the opportunity of rising to masterships of their own trades, to grades of overseerships, to duties of superintendence or of design, no doubt a considerable number of the former would enlist, if only the detail of the code of regulations be judiciously and equitably devised; so that the position of a man, in other respects yielding precisely the same service as civilians now do, should not be deteriorated in his very employment, as is now frequently the case, merely because he also served his country as a soldier. Of this body the artificers at least are superior to the general class of men who now enlist, and in so far, the addition to the army would not be of numerical strength alone, but markedly of efficiency and value. In fact, were it determined to procure the enlistment of a better class of men than is obtained at present, the means employed would be an increase of bounty and of pay, and a well-grounded expectation of improving prospects. It may therefore be fairly assumed that on the establishment of these conditions, their favourable influence would be felt by the army generally, although they had not been adopted primarily with that object, but were simply incident to the extension of a military system for the provision of works.

With regard, secondly, to the proportion of the existing army that would be directly affected, it must be conceded that, inasmuch as the invariable demand of all agencies that seek to promote the amelioration of any class of society is for money, the presence of money in the question is at the least not necessarily unfavourable to its satisfactory

* I believe it has been recently decided that the windage is a chief cause.—M.H.S.

solution. The matter really to be considered is, how the soldier can be induced to make a good use of his earnings in a manner consistent at once with his absolute property in the same, and also with his discipline and with his position as a soldier.

If opportunities can be set before him for the investment of his earnings in a manner alike beneficial to himself and to the state, and if inducements strong enough to cause him voluntarily to act upon them can also be brought to bear upon him, the object will be attained.

It is not difficult to point out an opportunity and an inducement of sufficient force. These can be afforded the more easily, since the numbers employed upon works would always be but a certain proportion of the whole army. The privilege of being so employed could therefore always be withheld from such men as were found to make a bad use of their earnings, or to be unwilling to adopt the approved arrangements.

Giving the soldier of a certain standing greater liberty of marriage, throwing upon himself all the consequent expenses, would afford both the opportunity and the inducement. There are grounds sufficient for inferring that such liberty would act as favourably upon the general health, strength, and morality of the ranks as it would be effective in reducing the unproductive expenses of that portion of the service. The additional requirements of a married soldier form, in fact, the barrier that restricts the permission to marry to a very small proportion. These additional requirements are, increased accommodation in barracks or quarters, more medical attendance and additional transport. These, as is obvious, can all be met without great difficulty, *in the presence of adequate funds*, merely requiring judicious regulation. The execution of works would supply those funds; and meeting these wants would be their best investment by the soldier.

No doubt there are many officers, and amongst them officers of much experience and of well-earned reputation, who look upon the possession of money by the soldier as his greatest temptation and misfortune, and who would be disposed to look with little favour upon propositions for giving greater liberty to marry. They hold that as a rule the soldier is the scamp of the town or the refuse of the village, with tastes bounded, at the best, by the canteen. There are officers on whom their own experience has worked a strong conviction, that a brave and useful soldier may yet be in all other respects a thorough blackguard. Indeed, it is not very long ago since a proverb was rife closely connecting infamy of disposition with value as a soldier. If this be the right view, nothing can be said. All projects of amelioration are alike hopeless. Far from being brought forward, the soldier ought to be removed from every place of trust, even in his own profession, wherever it can be done. A class that could be viewed only as an inevitable evil, which in times of peace and prosperity has been called so bitterly and so contemptuously a shilling's worth of food for powder, ought to be limited to the smallest number possible; but if this be the correct view, there are quite another set of votes to be dealt with. The educational and sanitary projects, the whole esta-

blishments of chaplains, and the vast machinery and outlay which have been the work of recent years for the improvement of the soldier, ought in all consistency to be abandoned without farther loss.

There is, however, quite a different and a better light in which to take these votes. They show that a better and a sounder opinion prevails even now, of the real characteristics of soldiers, a truer standard of what they ought, and may be helped, to be. These votes are the result, moreover, of the increased interest in and attention to military matters which the events of recent times have forced upon the country. Nor are these very opposite opinions so irreconcileable as at first sight they may appear. Ordinarily a man is very much what circumstances and inducements make him. Granted that a casual sum of money may prove the occasion of the greatest misconduct of a soldier with no other inducement to its outlay than the canteen can offer,—granted that some commanding officers may conceive themselves borne out by every instance within their particular experience of the bad effects upon the conduct and discipline of their own regiments, of sums earned on occasions of working parties having been furnished, yet it would by no means follow that any like result should attend the systematized and constant employment of military labour upon military works.

Quite the reverse. Else the Royal Engineers, the Commissiariat Corps and the like, would be the worst and not the best conducted and most trustworthy components of the army; and similarly, the Guards and cavalry, with higher rates of daily pay, would be inferior to the line.

The soldier will do with the wages of his work very much like any other man, what he may have the opportunity of doing; what he may be judiciously induced to do. If hitherto he has spent his chance earnings at canteens, has it not been very much the consequence of circumstances? In part, because they were *chance* earnings; in part, because the temptations of the canteens were at hand, not so any definite want or inducement to exert upon him the force of a less unfavourable influence.

The foundation of the manliness of the English character, the essence of its greatness and its strength are, perhaps, speaking of qualities alone, its self-reliance and its independence. The feature that peculiarly marks our military administration has been to do everything, and, as it were, to think every thought for the soldier. He is brought not only to habits of absolute obedience and of perfect discipline within the duties of his calling, but beyond the range of these he has been practically very much reduced to the conditions of helplessness and childishness.

His marrying has, as a rule, been necessarily inhibited. His chaplain, his school, his library, his reading-room, his ball courts and his canteen, all are provided for him. It is only at the last that he is called upon to spend his own money, and to bring his own faculties into exercise before he can make use of the establishment.

I do not wish to be misunderstood. Since this paper was drawn up, there have been many modifications. Soldiers now subscribe to

reading-rooms, and to other similar improvements. Still the canteen remains a prominent attraction; but the observation hardly now holds true, that it is *there only* a man must exercise his faculties and choice.

Yet, notwithstanding the general inhibitions of marriage, the proportion that are allowed to marry, and the proportion that marry without leave, form, with the consequent number of children, one of the most difficult elements of the army to deal with satisfactorily. Small and insufficient as that proportion relatively is, it crowds a barrack, or else renders its construction enormous. It is in the way in the allotment of camp accommodation; it is *the* difficulty on board ship. On the march, or on embarkation, many women and children are necessarily left behind; many families become destitute and fall a burden upon the Government or upon the parish. Yet the large *un*married proportion of the army does not generally yield the oldest, the best, the steadiest, or the most trustworthy and available soldiers; but it *does* furnish the principal ingredient of the hospital and of the military prison. An ingredient so large, so important, so damaging and so costly, that it has been found that a proportion as great as one twenty-fifth of the whole army is permanently supported either in the hospital or in the prison, unavailable for service and heavily encumbering the estimates, utterly unprofitably.

The employment of military labour on military works opens a solution to these difficulties. It affords the opportunity of throwing the expenses incidental to marriage, upon the man himself, as is the case in every other condition of life. The service is freed from the responsibility and the Government from the burden, of providing them, whilst the soldier himself is put in a position to earn and to provide them. In fact, the pressure that is now experienced has been caused in a great degree by the soldier having had no opportunity of making any such provision, whilst continuing his military service. It has resulted from an artificial practice, that has shut him out from a field of legitimate employment, and which has inevitably carried with it other restrictions, artificial consequences, forced necessities, and mischievous habits. When this practical prohibition is discontinued, and military labour resorted to within its proper sphere, these evils will also cease. The soldier will be placed, in respect of his domestic life, upon his own industrial resources. He will be enabled to supply and satisfy his own wants. No means has hitherto been practised; he has either been refused the habits of natural life, or he has been supplied at the cost of the country with the necessaries consequent thereupon. He has either been forbidden to marry, and condemned to an unnatural celibacy, or his wife and children have been housed, fed, schooled and physicked at the cost of the country. These extremes and this anomaly may be ended, the moment the soldier himself is placed in a position to meet the expenses of providing for these wants. The experiment of throwing the soldier more upon the result of his own exertions has succeeded to the extent that it has been tried; the employment of military labour seems admirably adapted to its wide extension. In particular cases soldiers married with leave have been accommodated with quarters under light payments. The supply

of rations at fixed charges is on the same principle. Similarly if quarters in or adjoining to barracks and camps (with a garden ground where practicable) were let to married soldiers at rents, light but still remunerative, and if by an arrangement similar in principle, the transport of his wife and family to his station for garrison duty were provided (not necessarily in the same vessel as himself), or that family allowed at his option to remain in the abode they rented at the time of his departure, or in one similar, the service would be freed from the greatest impediment and hindrance to the quick, easy and compact movement of troops. The free percentages already conceded, could still, if it were desired, be provided in the quarters or in the ships, under fixed charges for the others. Such an arrangement might be made with advantage both to the country and the service even as it is, for it is the helplessness of the soldier and his ignorance of civil life, which, together with the avaricious and passion-pandering characteristics of those who generally inhabit garrison towns to make their prey of him, that complete the position in which he falls under the influence of the canteen or drinking shop, exercising no thought beyond the moment, and without help in the hour of need.

In like manner with regard to the younger and unmarried soldier, a more extended system of recreative amusement,* both in the way of bodily exercise and of mental cultivation, would afford a wide scope for a beneficial expenditure of his working pay. For example, *his own* ball-courts, cricket, and game grounds of all kinds, with refreshments, all under judicious regulations, but in measure or wholly originating in his own resources, and under his own management—the more thoroughly under his own care and management the better; his reading-room and library, his club, in fact, similarly governed, would doubtless be found full of fresh attraction.

A fund, to which contribution should be compulsory on all allowed to avail themselves of the privilege of going on the works, would meet the cases wherein the misconduct of individuals, after being allowed these indulgencies, would have otherwise involved the country in expense. A proportion of their countributions to this fund, greater or less, according to circumstances, might be repaid to men on their discharge after a term of unbroken good service, which would probably cause the fund to be approved by all, excepting such as might forfeit their share on transfers, or by any other expenditures, incurred through their own misconduct. To others, it would prove, in fact, somewhat analogous to a savings bank, and it would be the common interest of all to prevent this diminution of the fund through misconduct. Thus, both in the case of the married and the unmarried man, the execution of military work by military means, far from exercising a deteriorating influence on the discipline or habits of the soldier, through the wages received for work done, affords the means of solving, without involving the country in any additional expense, one of the most difficult problems in the management of the army, as well as the opportunity for carrying out military life in accord-

* Recreation rooms are carried out upon this plan with the best results.—M.H.S.

ance with the laws of nature; yet it would at the same time both greatly reduce the non-effective expenses of the army, and facilitate its accommodation in barracks, as well as its movements on ordinary service, nay, even on active service, in so far as it would leave the soldier's family better provided for when he himself was called away from beside them.

Next, as to the value of military labour in getting work done. Under this aspect, the question is simply a consideration of relative cost and of sufficient workmanship. In viewing it, however, from this exclusively constructive and civil point of view, it is very necessary to bear in mind that the result arrived at must be modified by the value to be attached to skilled labour, as an essential and indispensable ingredient of an army before the inquiry has been practically dealt with in its completeness and truth.

Moreover, in instituting the comparison itself between the cost and quality of civil and of military labour, it has to be remembered that the regulations which now affect the latter are, as it were, incidents merely in the code of military rule, and that they have not been framed with the primary object of using the labour of the soldier to the best advantage.

A comparison, however, has been instituted under these conditions, which are necessarily less favourable to military labour than would be the case were it generally employed, and adequately organised for that end. Sir J. Fox Burgoyne has published, in his "Military Opinions," the very careful analysis given in full detail by Quartermaster Conolly, of the Royal Engineers, who has written the history of the late Royal Sappers and Miners. It appears from this analysis that the entire cost per man on a company of Royal Engineers, does not exceed 3s. 4d. a day each, when every expense has been included of bounty, drill, instruction, barracks and hospital accommodation, provisions, working pay, clothing, and pensions. Quartermaster Conolly shows a saving of £614 15s. annually on the employment of a company of Royal Engineers, instead of a corresponding number of civil artificers, of the trades which constitute by regulation a company of Royal Engineers.

[Since I have taken this from the sources quoted, I have seen compilations made by brother officers on entirely different data, thrown together differently, yet resulting exactly in the same amounts. This is corroboration, although it may be said, that corroboration on a subject like this that Sir John Burgoyne has adopted and given his countenance to, is like "painting the lily, and gilding refined gold."]

Upon this, General Sir John Burgoyne observes:—"As the work "must be performed, and as the engineer soldiers are intended to be "habitually employed in work, it is evident that the difference of cost "of what is performed by them from what it would be by ordinary "means, will mark the *bonâ fide* expense to the country of their "maintenance."

Since the work must in any wise be done, the result is practically that the country obtains the war services of as many men as are employed upon works in time of peace, not only virtually free of cost,

but at a positive saving, which on the aggregate of works would amount to a very considerable sum. These men are besides of higher average individual intelligence than those who usually enlist; they become trained soldiers, they are taught the duties connected with the operations of an army in the field, and more particularly at a siege; but notwithstanding these admitted facts, military works are principally carried out by civil instrumentality throughout, whilst the number of these combatant men maintained is only 40 companies, or 3,818 men, (exclusive of two troops, or 4,294 in all) or about one-fifth that of the Royal Artillery, two-thirds that of the Foot Guards, and is very nearly equalled by the rifle brigade alone.

According to the authority above quoted—and none could carry greater weight for accuracy and experience in this matter—the saving in executing military works by the Royal Engineer soldiers instead of by corresponding civil artificers, would be, by the analysis afforded, about 8 per cent. It has indeed also been said that this comparision is instituted with a class of artificers somewhat superior to the average of Royal Engineers; but against this must be set the fact that in the extensive adoption of military labour a large proportion of that required, could be and ought to be furnished by a class less costly than the artificers of the Royal Engineers. There is in every regiment a number, greater or less, of men, who although not absolutely capable of executing artificers' work independently, are quite able to work under trained artificers, of acquiring a good degree of handiness, and of becoming at the least more full of resource than they are on their enlistment. They are well fitted for helping in rougher kinds of work, and for acquiring an aptitude invaluable in the emergencies of actual service. To men of this description, who are of a class especially calculated to make good soldiers, the prospect of employment on military works would be as attractive as it would prove beneficial to the service, so that whilst the combatant force would be added to in one of its most valuable elements, the work suited for execution by such means would be performed by the instrumentality most appropriate, and in part less expensive than that on which the above comparison has been based.

Contract, however, and not the direct employment of civil artificers, is the system almost invariably pursued. This circumstance introduces another element of uncertainty in estimating the positive relative cost, but it is probable that the expenses involved in the contract system are in some cases in excess, and in others below those on which the above estimate of civil artificers has been based.

Be this as it may, and the *amount* of saving that would ensue proportionably difficult to determine, it can but too easily be shown that the merits of the question do not rest upon absolute accuracy in this particular. The army estimates for this year, 1864–5, amount to £14,844,888, of which the charge for the effective services of all kinds, exclusive of militia and volunteers, is £11,579,802. That for works and buildings is £750,870, and any instrumentality which would reduce so large an expenditure, were it only by a very slight proportion, is as deserving of consideration for its financial bearing on the

aggregate army estimates, as that proposed has been shown to be to military economy, and to the soldier's general efficiency and well-being. This is clear, for assuming that of the £750,870 for works and buildings, one-half only represents payment for labour, and that the rest is for materials, in which there would be no change of cost, the employment of military labour would yield, *first, a combatant force equal in numerical strength to the number of civil artificers and labourers employed throughout the year*, and of the qualifications of the Royal Engineers; *and, secondly, a saving* varying respectively at ten, five, or one per cent., from £5,000 to 25,000, and £50,000. At fifteen per cent. the saving would be £75,000 a-year.

As has been already said, however, the true value of military labour in the execution of military works must not be tested from a financial point of view exclusively, be the result ever so satisfactory, or rather if it be so tested, it must be on a full view of the whole case. The indispensable necessity of skilled labour in modern warfare must have the weight and prominence which are its due. The extent and quality of skill that, if not altogether indispensable, it is yet of the utmost advantage to have at command, must also be considered. If the question is to be determined as a matter of finance, the monetary value of such skill and practice in the emergency of war, and that of the best school for procuring and for maintaining it must be added to the score.

The DESIGN AND SUPERINTENDENCE of the works required would supply and cultivate the higher portions of this skilled labour. Upon the mode of carrying these out must depend in a great measure not only the success, or otherwise, of the military execution of works, but also whether or not a large body of officers, non-commissioned officers, and men, is to be maintained, trained, and employed to the greatest advantage, and available at any moment, with matured experience, for active and immediate service in the field.

Superintendence must necessarily be carried on either by military, civil, or by mixed means. A wholly civil instrumentality need scarcely be discussed.

The requirements and constitution of an army necessitate, at the least, a military admixture. Military men must, or certainly ought to be, better acquainted than others, both with the wants of the service and with the best ways of meeting them. Officers conversant with the operations of a siege, and with many other matters of field service, are indispensable. These must clearly be trained in time of peace, and their general services ought also to be then available. To supply this indispensable need, and to provide this training, the corps of Royal Engineers has been formed and organised, and placed in charge of all fortifications, with the buildings and lands attached, and of the superintendence of the execution of all works and buildings.

Owing to the great preponderance of the execution of works by civil means, the officers of this corps are in point of numbers proportionably in excess of the corps of artificers whom they now officer under a common name; but the non-commissioned officers of this body ought to be similarly qualified to conduct the subordinate duties in the super-

intendence, and their employment in this manner, a practice already in partial operation, might readily be organised so as to be attended with great advantages.

If these together be in sufficient number, there is evidently no need of the addition of a civil admixture, and the latter can only be introduced to supplement some deficiency, real or supposed, in number or in qualification.—[See Appendix A.]

The substitution of a military system is rendered comparatively easy, inasmuch as the present system has in all respects a partially military organisation; and a gradual increase of the military features would effect the transition to its complete adoption in the best manner. Thus carried out, no injury whatever would be inflicted on so much as the prospective interests of any of the civil assistants on permanent employment; and no additional expense would be incurred even at the first beginning of its more extended application; no difficulty, shock, or inconvenience would be felt in the working of an existing system, as there would be no sudden substitution of either one class of persons or of duties for another. The transition might be begun by replacing the civil temporary appointments, of which 87 appear in the estimates, by as many military substitutes as might be found at once available and competent for the purpose. The employment and promotion of the permanent civil assistants being carried on with no other change than the cessation of new civil appointments at the bottom of the lists, their interests would be left entirely untouched, and their services would be available as now; only they ought to be placed exclusively as assistants to senior officers, where they would be *assistants*. And they should be employed in training to the duties of superintendence, and to the minutiæ of plans and estimates, the best tradesmen amongst the non-commissioned officers and men, precisely as they now do their civil juniors. They have themselves been trained in this manner, and have thereby become gradually familiar with the general duties of the service after their own special apprenticeships in their previous civil life.

In order fully to obtain the advantages that are to be derived from the employment of military labour in the execution of works, both in respect to the labour and the men themselves, a brief code of regulations is required, framed with especial reference to these points, and to the co-operation, or the reconciliation, so to speak, between military duties and the employment of labour to the best advantage. The former of these objects, that is, the due performance of military duties, has frequently been quoted as an insuperable obstacle to the perfect attainment of the latter. All, however, that would be necessary in order completely to secure it, would be, to determine first the amount of military duty necessary to be performed, and then to carry it out subordinately in point of *time*, to the particular work or job on which the man, squad, company, detachment, or regiment might be employed; the *amount* being absolute and paramount, but the *time* or roster varied under the orders of the officer commanding, according to the work actually in hand. Although carried on at special times and in special localities, the course of musketry instruction now in force

does not militate against any other of the soldier's duties. The principle of the two cases is not dissimilar.

To promote diligence and good workmanship, and an effective control over the working parties, a revised scale of pay, ranging, it may be, from 3*d.* to 1*s.* 6*d.* a day, is necessary. Day, task or job work should be alike authorised at the discretion of the officer commanding the works. To meet cases of misconduct, and to maintain employment on the works as a privilege, men abusing this privilege should be liable to be transferred, until restored, to companies or regiments debarred from such employment; and a clear distinction, both in duty and in liberty, should be maintained between such cases and that of others likewise not upon the works, but that from choice or from honourable causes. There should be besides a clearly defined system of promotion to the positions of master tradesmen, and to duties of superintendence and design. Both in rank, by warrant, and in the higher grades of non-commissioned officers, and in pay, these positions ought to be made as well worth attaining as is properly called for by the duties to be performed. The effect of such a warrant and of such new regulations upon enlistment can scarcely be questioned.

At the same time, no additional expenditure would be incurred, because it is proposed that the military, as well as all other expenses of the men executing the works, should be defrayed from the cost of those works estimated according to the present system, and from the expenditure now incurred on the existing system of supervision. On the other hand, it is not intended that the whole reduction that might ensue through the substitution of a military system, should be treated as a saving; but that a proportion of it should be devoted to preparing for its extension and for perfecting its application, as well as for ensuring a due remuneration and a sure prospect of advancement to those who qualified themselves in its several gradations of duty.

With the exception of the very small present number of Royal Engineers, no account is taken of military labour in the strength of the army voted in the estimates. That strength is determined entirely on other considerations. Accordingly it is not proposed to entrench for the performance of the additional duties occasioned thereby upon the force deemed necessary for other purposes; but, as has been explained, the army would be added to to an extent equal to the number of men required and found qualified and available for the execution and supervision of works. Probably it would be best in the first instance to add the increase of effective force thereby obtained to the existing companies of engineers. That body is, as has been shown, not only disproportionately and disadvantageously weak in point of numbers, but the advantages and prospects that would be thrown open to first-rate artificers through the expansion of the system of the military execution of works, would enable not only the number, but also the qualifications of that body to be raised more and more, both to a higher standard and to a more uniform attainment of that standard

In its degree it is an object almost as important to impregnate the

whole army with the spirit of work and of well grounded self-reliance, and to extend as far as possible to the whole that general aptitude for the emergencies of war, and to throw open to the whole those advantages in time of peace, that have been already considered. A real head-quarters for the Royal Engineers would almost be rendered necessary by, and might not be among the least of the advantages arising from, the military execution of works both in respect of duties of peace and those of war. By this means, among others, the high training received by the officers in early life would be maintained, and its effects fostered and turned to account through life. This head-quarters should also be the resort of other officers, and, at stated times, of other troops, who should be collected for joint operations by the several branches of the service, on a legitimate and proper scale.

It may admit of question whether the addition of the labourer's part should be made, except in limited proportion, in the same manner, or embodied in additional regiments or in special companies of Engineers, or attached to that corps. A mere numerical addition to the army would seem sufficient for the purpose. The authorised adoption of the system would lead, as to a natural consequence, to the stationing of a proportion of troops, with especial reference to works in execution or requiring maintenance (more particularly at the larger stations, and always, be it remembered, free of additional expense). This would enable working parties to be habitually drawn from regiments without in any way diminishing the strength at present concentrated for purposes of joint drill, and by adopting the principle of time and of rotation by regiment, company, or squad, according to the nature of the case, without disintegrating any sub-division of that force. It would also extend to every regiment, according to the use it made of the opportunity afforded, a portion of the advantages thrown open. It might be advantageous to both officers and men to draft the men taken from regiments into companies temporarily attached to or amalgamated with the Royal Engineers, particularly when their services were wanted continuously, or that they were partially qualified for skilled labour. On the departure of regiments from a station, or for foreign or active service, the trained men might be returned to the regiments, or not, by the decision of the Commander-in-Chief, according to the destination and the nature of the case. The deficiencies caused by the temporary or permanent transfers having been meanwhile filled as is now done in similar cases on a limited scale, the numerical adjustment would be maintained on the return of the trained men by the withdrawal of an equal number of men who had not been upon the works. The services at minor stations might be readily performed by an organisation similar in principle to the Coast Brigade of Artillery; so also as to barrack damage and hospital repairs and a great deal of store charge, at a great reduction both of cost and of complexity of arrangement.—[See Appendix B.]

In closing these remarks it may perhaps with propriety be added, that scarcely under any possible conditions could an accession of strength derived from a costless increase in the number, and from an aggregate improvement of the individual members of an army, be of

greater importance than in those which form the actual circumstances of Great Britain at the present time, with a comparatively small amount of population, an enormous and wide-spread territorial empire, and upholding and dependent for her very being upon principles of conduct alike removed from despotism and from anarchy, in the support of which she stands almost or entirely alone. Since she maintains, moreover, an increased military force, and incurs an increased expenditure for military purposes only under apprehensions of unusual magnitude and severity, the difference should not be forgotten, both as regards the country and the men themselves, between large bodies of men returning to the civil avocations of life (whether under the operation of limited enlistment or upon reduction) who have either become, as it may be feared is too often the case at present, in a great measure unfitted for all but the habits of the profession they have quitted, or who under the system proposed will have been exercised in various branches of industrial pursuit, and who not improbably will have become better citizens and subjects than they were when they first adopted a military career.

Lastly, I wish to say but a few words, not so much with a view of seeking to refute objections, as to prevent objections being raised on misapprehensions through want of explicitness on my part.

My proposition is, that it is better and cheaper to do military work by military than by either civil or mixed means.

Better and cheaper, among other reasons that have been already advanced, because two ends, as it were, are then accomplished by a single means, for officers and non-commissioned officers perform the military as well as the structural functions of their respective offices, whereas now two means, one military and one civil, are employed to attain, or it may sometimes be, to obstruct a single end. All expenditure incurred would tend at once and directly to its immediate end, and to the final end of all military expenditure whatever, viz., fighting power.

My illustrations are taken from existing facts.

My reasoning is limited to advocating the doing on a larger scale, what has been proved to answer under restrictions and disadvantages, nevertheless, the suggestions I have now had the honour of submitting to your consideration have not been hastily formed or adopted: on the contrary, they embody convictions and opinions the result of my whole length of service, such as that is. Neither have they been thought on, elaborated, or brought forward in any partizan spirit or personal interest.

They are not advanced for the sake of benefit to either Engineer officers or men, although I believe, if adopted, they would have that effect and that tendency.

It is not so much in even the interests of the army at large that I wish to bring them forward, as because I believe them to be founded on plain and simple, but, at the same time, powerful and important principles, and that they would have the results I have stated. I respectfully urge upon you their consideration, chiefly because whatever would increase the positive efficiency and the numerical strength

of the army with less rather than with increased expense, is, more especially in this eventful era, of interest and importance to every Englishman and to the whole country.

If I am right, moreover, in my strong conviction, that industrial training and practice are calculated to make the soldier a better subject than he was before, I do not think that the improved esteem in which discharged soldiers would then be held, and the reactive and insensible influence of this again upon enlistment, and so upon the army, ought to be forgotten.

In claiming, therefore, through your influence the consideration for this subject which I believe it to merit, I am peculiarly anxious not to be in any degree misunderstood.

I can imagine objections almost without number; but they are objections founded on an incomplete view of the whole.

It might have been assumed that I sought to benefit the corps interests of the Engineers, and so indirectly my own. I do not acknowledge the charge.

It may be said, I give a preponderance to the army at the expense of doctrines of political economy. The supposition would be, I believe, equally fallacious.

The military works wanted are but works wanted by the country, and necessarily supplied from its resources. The artisans of the country can then be nothing injured by a proportion of them being induced by advantageous terms to yield military service as well as their skill; but powerful inducements to good conduct, acting on a numerous class, must benefit the community at large. The opposition that has on occasion been raised against military labour is, in truth, far more opposed to common fairness as well as to sound political economy, and has in it far more of the spirit of dictation, of caste, and of self-seeking. It is an attempt on the part of powerful sections to prevent others from the exercise of the same crafts and of the like abilities: a spirit and an attempt that ought to be refuted and discountenanced, and not yielded to or encouraged.

Should it be said on the part of the army that its members enlist to fight and not to work, I can have laboured to very little purpose if I have not made it clear that all my aims and endeavours are to refute the spirit of this objection; that it is my whole object to enable the army to fight to better advantage,—to increase, as I have said, its fighting power in respect both of number and of individual and personal efficiency.

If it be said by any of my military brethren that I have sought to add a new and onerous duty and responsibility to our present labour, I must not and I do not wish to deny it. Carrying out work throughout, from its first design to its final completion, is a very different thing to supervising contract work with no interest in the men and no responsibility in the work beyond that of approving or condemning what others have to do. I have not sought to make Engineer duties more light, but to suggest a Constructive Service soldierlike, efficient, and complete for every part of the constructive duties required by the army.

Possibly some civil engineers, all of whom do not, I fear, display at all times the candour and courtesy towards their military brethren which, I trust, they invariably receive themselves at their hands, may be disposed to dispute the capabilities of the military service to furnish the requisite ability or the technical knowledge. I trust I have sufficiently met this point by that part* of my paper which deals more particularly with it, in the system of training and of gradual substitution not to have now to institute comparisons, nor to press the general qualifications of a body to which I have the honour to belong. I prefer altogether to waive this point, not caring to discuss it, because it is not essential to the subject. No one, I presume, will dispute that a military body may be formed capable of doing all its work, even were there no such thing at present. Moreover, it must certainly be conceded that this straining for assumed excessive technical attainment scarcely seems to be countenanced by the high authorities whose decision determines these matters, at least as to that part of the duties under consideration that relates to maintenance, and is now done by civil means, inasmuch as precisely the same kind of work which, if done as an Engineer service, would be subject to the technical skill and complex machinery of that department, is deemed sufficiently provided for without either one or the other when entrusted to barrack-masters or purveyors instead.

The civil assistants now in employment may be disposed to view with little favour a proposition for nothing less than the eventual abolition of their order; but all their interests, present and prospective, are carefully preserved and their services are retained, only they are placed to the best advantage. There can be no question as to procuring military substitutes in the manner proposed, for they can be obtained already. Some at least of the existing military foremen of works taken from the Royal Engineers are more than ordinarily efficient, and will bear comparison with any other class most favourably.

My object, as I have said, is not to advance corps interests of any kind, but to see army constructive services effected in what I believe the best manner possible. Just as these can be best performed by an entirely military organisation, they would, so done, form so excellent a school of military adaptability and efficiency of all kinds and for all grades, that a twofold injury is inflicted when they are not so done, and such a school is practically lost. Certainly under a different system the talent that may lay dormant till it die in the corps to which these duties are deputed in whatever manner to be performed, might be turned to far better account; but I have not stopped short with this aim. Could my wishes carry any fulfilment with them, they would be very earnest that the supply of all the soldier's wants should be deemed an essential and indispensable part of a soldier's duty; and if a better or a worse decision than is made in other countries shuts out from the hope of honour and distinction by far the greater proportion, if not all, of those to whom these duties are now allotted, a remedy reaching farther than the disease itself would be, to open the school

* See Appendix.

instead of the preferment, and to train in the school of meeting these requirements, those who are destined to command and lead to victory the masses, of whose wants we have been treating, and whose work they ought to be; in other words, the point I seek to establish is this, that its constructive services are properly the duty of an army and an invaluable military school.

The CHAIRMAN: Gentlemen, Colonel Synge has not only offered to answer any questions that may be asked him, but he has invited a canvass of his opinions; and we shall be very glad to hear if any one objects to or offers any suggestions on that which he has brought forward. I hope we shall have the benefit of the opinions of experienced officers upon this subject, which is one well worthy of consideration. Colonel Synge has modestly laid claim to no originality, but he is the first to offer a solution of two of the great difficulties of the day with respect to the army, namely, the questions of marriage and of limited service. He has shown us in what manner these difficulties can be overcome with benefit both to the soldier and the state. His opinions are supported by the fact that the pickaxe as well the sword have been said to be the badge of the Romans' conquest. The greatest military power in the world employed their men upon what we call civil works in times of peace; and the consequence was, that they were sounder, hardier, and healthier men in time of war. The latter portion of the paper is so much connected with the Engineer service, that if there is any officer of the Royal Engineers present, I hope he will say a few words upon the opinions of a brother officer.

Sir HARRY VERNEY, Bart., M.P.: I came here this evening hoping to hear the opinions of engineer officers who have had the same kind of experience that Colonel Synge has had. For I feel it to be of great importance to those who may advocate the employment of military labour, that, when the Army Estimates come on in the House of Commons, they may be able to say they have heard statements from those who have tried the system, that not only the employment of military labour will not interfere with military duty, but that it will render the army altogether more efficient. I entertain no doubt of that myself, and I hope to hear military men speak from their own experience to the great importance and value of so employing soldiers. One great object of the present day is to render the soldier as moral and as good a citizen as possible. I confess it is my ambition to see the day when the return of a soldier to his native village will be hailed by all the respectable inhabitants as an acquisition; when, instead of returning with something of the character that Colonel Synge has described, he shall return a much better member of society, coming to practice in his native village the trade he has learned in the army, and able to earn a respectable livelihood. In this way he will hold out an example to younger men that they cannot do better than enter the service; in short, holding out an example which the most respectable men in the village will be inclined to follow. I feel the great importance of this, for I heard it stated by a military man of great experience, a few days ago, that the men who are now coming into the army are less respectable than they were a number of years ago. It is owing to this, that almost all occupations are so highly paid now, that young men find they can do better for themselves than by going into the army. But if by entering the army, they are taught some trade, their opinions would be different; and I really think in this way a higher class of young men might be induced to go into the service. The gallant gentleman who has read the paper did not advert to the different occupations in which a soldier's labour might be employed. I recollect the last time I went over a French barracks, the officer who went round with me took up a soldier's shako and said, with the exception of the eagle on the shako, the whole of the soldier's dress is made in the barracks. Accordingly we went into one room, and there we found tailors at work; and in another, shoemakers; in others, all sorts of trades and occupations going on; and in the last which I entered, there were a number of Frenchmen dancing and pirouetting as hard as ever they could. They were jumping and performing all sorts of antics; I could not help thinking that I should like to see

our fellows doing the same thing. I then went to stay with an old friend of mine belonging to the French army, who had 40,000 men under his command. He said each thirteen men had a space given to them with poles and rafters, and they were allowed to cut their turf coverings for their huts, and to construct them as they pleased. Some of them built their huts upon two stories, and so they had rather more space for a garden; others built their huts on one story; and in almost all cases there were maps and sketches and all sorts of things done by the private soldiers, with which they had ornamented their huts. It evidently gave them a great deal of amusement, and a great deal of very useful occupation. With regard to the expense, I must mention what I quoted in the House of Commons. I think it was Major Buckley, the barrack-master at Chatham, who stated in his reply to the queries put by my honourable friend on my left, General Craufurd, that when he was in Jamaica, about thirty years ago, he built a target which had been constantly used ever since. That target was found to require some repair, and the repair of it alone was estimated at £200; whereas all that it cost him, and all that it cost the country, was three dollars in the construction. He employed the men under his command in the work. That shows how important it is to employ these soldiers in service of this sort. For my part, I believe the more they are employed the more popular the service will become, and the more efficient and the more respectable, and the greater the advantage which will accrue to the country at large.

Lord RANELAGH: I quite agree with the honourable gentleman who has just spoken, and I must say he has added one word that is the most important we have had to-night. That word is "trade." If we could introduce the system in practice in the French army, and make every man learn a trade, it would be a great benefit. But I cannot agree with what has fallen from the gallant lecturer, that there is the slightest chance of soldiers being employed on what he calls military works. I will ask him to illustrate more than he has done what he means by military works. I would put it to him in this way: What are those military works that he contemplates, and how are the men to set about them? I do not mean the mere digging of trenches, and throwing up earthworks for batteries. He goes beyond that. I would ask him how he would employ a regiment of Guards, and how he would employ a regiment of the line quartered, say, at Portsmouth?

Major LEAHY, R.E.: I rise with very great deference to observe that the question has not escaped the attention of the authorities. At the present moment, there are extensive military works being carried on exclusively by military labour. I allude to the new fortifications; they are being carried on under circumstances which when the proper time arrives, will enable the country to determine the value of that kind of labour. Under the suggestion of Sir John Burgoyne, with the approval of the Secretary of State for War, and with the encouragement of the Commander-in-Chief, some of the military works at Dover and at Portland, are being carried on exclusively by military labour at the present time. A large work of the estimated value of £80,000 was commenced by contract labour. Circumstances arose which rendered it necessary to terminate that contract; the whole of the plant was taken over, and the department set to work on their own account. At the present time there are two companies of Engineers and a company of the line employed in carrying out about three-fourths of this work; and—I cannot speak exactly to the figures—a very large saving is being effected in consequence. In a similar manner, at another station, a company of Engineers, assisted by the Royal Artillery, and by the Line, have been employed carrying into completion a work which was commenced by civil labour. An exact record is kept, and it shows that a considerable saving has been effected, owing to the fact that military labour is paid at a less rate than civil labour. I have no doubt these facts will be brought under notice at the proper time; but I mention them now, in order that the meeting may not suppose that the question has escaped attention.

Major EWART, R.E.: It is well that an explanation should be made with regard to what has fallen from Sir Harry Verney, and relative to the comparisons which have been drawn, and which are constantly being drawn between the French service and our service, in respect to the question under consideration to-night. It must be recollected that the French service is dependent upon conscription; the consequence is,

that you get into the service a very different class of men from what you do in this country. In this country we have to go into the labour market, and to raise our men by money. It is a matter of pounds, shillings, and pence. In France they draw men of all classes, and they accordingly get into the ranks carpenters, tailors, bricklayers, shoemakers, and tradesmen who have been apprenticed before they come into the service. The great difficulty with us is to induce men of this class to come into the ranks. Taking an ordinary regiment, you find a very small proportion of what you call tradesmen. In recruiting for the Engineers, although we get a certain proportion of steady tradesmen, yet we get a large proportion of unsteady tradesmen. That is another difficulty we have to contend with in our service. If you employ men upon military works, you may have men who are very good carpenters and very good bricklayers, but you find many of them are drunkards, and you are obliged to send them back to their ordinary duty—you cannot continue to employ them. These are circumstances that ought not to be lost sight of in comparing our service with the French. The question of the great expense of the English soldier compared with the expense of the French soldier was under discussion in the House of Commons the other night. All that is dependent upon this consideration, that you find in the French service tradesmen of all kinds who may be employed at a very small remuneration. That cannot be done in our service, for the reasons I have stated. With regard to the subject of extending military superintendence, which has been mentioned to-night, I think the system in the French service of *corps-de-génie* answers extremely well, and I know no reason why it may not be extended in our service. Within the last two or three years we have introduced a class of military foremen, taken from the non-commissioned officers of the Royal Engineers, who are doing the work which is done in France by the *corps-de-génie*, and are doing it very well. In the French service they are substituted for civil clerks of works. A material improvement is going on in our army, as is shown by the works now being carried on. I may mention my own experience. I have had experience in the employment of troops in the colonies, in the camp, and in the field; and I have carried on the whole repairs of a camp in this country by military labour.

The CHAIRMAN: I don't know whether Colonel Synge adverted to the quality of the soldier with respect to saving. I think if the savings bank returns were referred to, it would be seen that our soldiers upon the very limited amount of pay which they receive are generally speaking more a saving class than the artisan who is in the receipt of very high wages. It is proved by the Savings Bank returns that our soldiers actually do lay by more money in proportion to their limited pay, than the artisan does out of his highly paid labour. As the advantage of industrial employment has been adverted to, I am induced to say from my own experience that it produces a very beneficial effect. My own experience is on a small scale, being limited to the staff of a militia regiment. The men are all employed, and they are all the happier for being so. There are a number of useful trades carried on in the regiment, to such an extent that the whole of my clothing store has been filled up by my own men. The consequence is, that what was estimated at a very high rate has been done at a very small one; and the men, who would otherwise have been in the neighbouring public-houses with nothing to do, are as happy as if they were all in one family. There is not only something to give them constant occupation, but there is something to take pride in; they take a pride in all these works, as much as if they really belonged to themselves. The trade of book-binding is one that has created so much interest, when some novelty happens to be introduced, such as a photograph book of a new description, that I have really had a greater demand upon my men in the book-binding department than they could comply with. This, I think, proves that we shall meet with success if we give encouragement to industrial occupations.

Lord RANELAGH: That is not military labour.

The CHAIRMAN: That is quite true. Colonel Synge will now be kind enough to answer your objections.

Colonel SYNGE: May I ask if any gentleman will speak upon the financial aspect of the question. Some elements of that kind have not been noticed, and there are gentlemen present perfectly competent to speak on matters of finance.

Sir Harry VERNEY: I may take the liberty of stating for the information of gentlemen, that only two days ago I waited upon the Secretary of State for War, in order to arrange with him a Return to be moved for in the House of Commons, to obtain the very information which has been referred to; namely, the number of men who had learned trades previous to enlisting, and the number who have been employed in their trades since they have enlisted.

Lieutenant-General CRAUFURD: I think there can be no question that the employment of soldiers of the line on military works is perfectly feasible, and not open to any objection whatever. I was stationed at Dover for a considerable period. One of the regiments of the line was employed in works of construction there, and I heard from the officer commanding them that they were men from the mining districts, and that they made themselves particularly useful. With regard to the proposal of Colonel Synge, that the men should be encouraged to marry, I must say that I differ from him with respect to that. I do not think it would be desirable to increase the number of married men in the army. Still, I have no doubt when a man makes a good marriage, it improves his character very much. We shall never have in the English army men already instructed in trades; but we may induce young men, who aspire to improve their circumstances, to enlist into the army in the hope of being instructed in a trade after they have enlisted, so that they may be able to get their livelihood by it after their term of service has expired. They will return to their communities with their characters raised, possessed of the means of earning a respectable livlihood, and they will thus be objects of congratulation to the communities from which they have sprung. If very young men enlist, the term of ten years will be a time of probation to them; they may be instructed in trade and may save money; and when they return to civil life they will still be young men, and can marry then, with much greater advantage to themselves than if they were to marry while in the army. For my part, I should be sorry to look to the promotion of military works by the soldier, with the view to increase the number of married men in the army.

Major EWART: I am afraid the difficulty we find now in one respect will be increased. If they are taught these trades, the difficulty will be to get the men to renew their enlistment. It is clear we shall want to hold out greater inducements to get them to remain.

Major LEAHY: It may be interesting to observe that in the Belgian army the soldiers are enlisted for two years only. A large section of the works at Antwerp have, however, been carried on by military labourers; and those military labourers have not enlisted as trained artificers. They have not only been employed on the works, but during the winter season they have been taught trades which in the summer season they have carried out in practice. So that in our service, with the encouragement which the employment of military labour now receives from the authorities, I apprehend there will be no difficulty in extending the system much more than has hitherto been the case. As a means of carrying it out, I quite concur with Colonel Synge, that military superintendence is essential to the employment of military men.

Colonel SYNGE: I have been unexpectedly gratified with the discussion. There are several points that have not been discussed that I wish just briefly to recall to your attention, because I am disappointed at their not gaining more attention. One is the financial aspect of the question; and the other, that which has been so forcibly pointed out with reference to marriage. With regard to the financial question, what I want to impress upon you is this, that by the course which I propose, we can relieve the Quartermaster-General's department of many of the financial difficulties which arise, I believe, in consequence of the present system of carrying out military works. Upon the question of marriage, I may shortly say that for many years I had been convinced of the soundness of my views in every other respect: but I never ventured to bring them forward, nor did I ever see the completion of them, until a casual remark was made to me with respect to the question of marriage. I must say that up to that time my own prejudices, my own views of the matter, were completely against marriage. I found everything else clear; but then the question arose, "What is the man to do with his money?" and I thought

it would only increase existing evils. I went into the subject in conjunction with those deeply interested in the improvement of the married soldier's position, and in all the circumstances connected with it; and it then appeared to me that a wider permission to enter upon marriage offered a complete solution of the difficulty. I may say, it is the keystone of the arch. Another point necessary for the complete cohesion of all these several parts in practice, is the training of the officers. What can illustrate the usefulness of training, through the execution of the works which you require for the army at all times, for a body prepared for service in the field, more strongly than the absolute necessity for there being such a body? How are you to train it better, and at less direct cost, than in the constant and complete provision of the wants of the army? What can show more strongly the incompleteness of the present system than the fact, that a vast proportion of the body now so trained is not available for military service? What I particularly want to bring forward is, that constructive duties ought to be the training school of those who are the fighting men. That this is consistent in principle, and cheap in practice. The noble lord near me has asked, What are the works which you wish to put them upon, and how is the work to be done? I maintain that everything that is required by an army, whether for its maintenance or for its duties, is a military work, and should be attained and carried out by the men who fight. The soldier may be likened to something like a snail; he should carry his house about on his back. Under his great coat he carries his knapsack, and in that knapsack is everything he wants. Now, as far as possible, I would have each man comprise within himself the ability to supply all his wants, and to perform all his duties, so that if you took the individual soldier, a unit as he stands, you should not only have a man who is to be shot at, but rather one who is superior to others, and able himself to supply all he wants as he goes along. Then you have a real soldier. And I believe ten such soldiers would be worth twenty that could not. That is my opinion of a soldier. It has been said that victory hangs on the side of large battalions. I say, rather, that victory attends *strong* battalions; efficiency, and not *mere* number. So that I mean by military works, everything a soldier wants, everything that is rendered necessary by his business; all this should be met by one who is a soldier. The subject hangs together. If you want to have efficient men who can meet all that you require of a fighting man, train them and employ them in the daily meeting of these requirements, whether in time of peace or in time of war, and you will have it: and do not go to an enormous expenditure for extraneous things, when a system of simplicity will meet it all. The War-Office expenses have increased 33 per cent. in two years, probably in a measure owing to the Indian amalgamation; but it is a very large expenditure, equal, as I have stated, in clerks alone, to 42 companies (4 battalions) of fighting men. I hold in my hand a letter, which I received from a person well-qualified to speak upon what he writes about, who adds his testimony to what has already been justified by other speakers, that where non-commissioned officers superintend the works, and soldiers execute the works, the result to the country is very favourable, and causes a large saving, and he sums up the whole matter in this way:—"There is no doubt that our army might be profitably employed in many ways with great advantage to the country." I have letters also from officers who have been employed in this manner almost on active service, to the effect that they have performed works in Canada at one-fifth the expense that they would otherwise have cost. I have known of cases where the saving on an annual sum amounted to one-half. As for increasing the proportion of married men, I do not think it will have that effect in the existing numbers. My proposal includes an increase of the combatant force equal to the number wanted for military works; and though I wish to increase the privilege of marriage very largely, yet to give an opportunity to a man to marry at his own expense, is a very different thing from throwing all the expenses on the Quartermaster-General's department. I concur in the difficulty that has been brought forward with regard to trades. I did not speak of trade being an advantage to soldiers as civilians; it is not my view to bring a man into the army, and teach him a trade, that he might then go out of the army again. That was not my view. Probably the House of Commons would veto a proposal for money to teach men a trade to be carried on in civil life; but my point is this, that by the present system

we are positively prohibiting men from the performance of their proper duties in their own business. A remark has been made on the difference between the French and English armies. But it does not apply exactly to the subject in hand. I have not referred to the French army, because comparison with the French army would not apply; but I know another instance, that rather corroborates the statement that has been made with reference to the works at Antwerp. I have known, not soldiers, but I have seen some two thousand and odd boys and men brought into prison at the time the system which drove men mad, of solitary and waste labour, was in competition with the natural way of dealing with that question, namely putting men to work. This latter course was then attended with a great deal of difficulty. There was a great deal of difficulty, in a case in which I know the facts myself, in contending with the prison authorities who were entirely against employment on works. But there was an arrangement made that gave a man a little more to eat. They were not at that time fed up to the masthead and made riotous, as they have been since. They were really well nigh starved, and these men were induced by the stimulus of a little more food to apply their latent skill. The late Lord Raglan was at the time about to go to the Crimea; and Sir James Graham performed in his place a tour of inspection. He was struck by the excellence of the work performed, after a very short time of training, by men and boys who a little while before had been Irish pickpockets, or criminals of a still lower grade. The old work had been justly considered model work as performed by contract, but that done by the convicts was as good. These were not soldiers who were taught to do the work; they were simply Irish pickpockets, whom the convict authorities of the day, moreover, drafted off to other places as fast as they could. That shows strongly that a soldier could do far less difficult work to great advantage, if he had a chance, although, happily, no conscription gives us a compulsory admixture of skilled men in our army. The substance of what I contend for is, that there are certain things which a soldier needs, which are not now put upon himself to meet, and that they ought to be imposed upon him; and that doing so would benefit the soldier, the officer, and the country, and in every possible aspect would be a benefit. The whole coheres; turn it in what way you may, it presents some advantageous feature, whilst the proposal is as simple as can be.

The CHAIRMAN: I am sure I shall be only expressing the opinion of the meeting if I convey your thanks to Colonel Synge for the interesting lecture we have heard. We are the more indebted to him, because the lecture has given rise to a very interesting discussion; and I think we ought to include in our thanks those gentlemen who have kindly taken part in the debate.

APPENDIX A.

Such, accordingly, appears to be the principle of the existing organisation. In the regulations furnished for the guidance of the corps in the performance of the duties allotted to them, it is laid down that "the direction, control, and responsibility is in the commanding engineer," and he is enjoined so to carry on the duty that "the whole distribution and detail of the execution of every service is to be conducted" under his own direction, with the direct object (which is expressly stated to be that of every regulation in the routine and detail of duty) "that the junior officers may have every opportunity of being fully instructed so that they may become competent to discharge the important duties of commanding engineer when that situation shall devolve upon them."

It is added that observance of the rules laid down will *ensure* that the younger officers become "conversant with every part of the service in which they are employed, from the formation of the design and estimate to the final completion and measurement."

So far there is no mention of nor reference to civil assistants. They are named for the first time in immediate connection with the particular duties of the junior officers, and consist of clerks and foremen of works and of clerks. More recently the foremen of works have been amalgamated with the clerks of works, so that whenever mention of them occurs, the present reading would be a senior and junior clerk of works.

The position and duties of, and the qualifications which these civil assistants are required to possess, are severally defined as follows:

Clerks of works have, "*next to the engineer officers*," "the control of the execution of all works and repairs," "and *in the absence* of officers at a station, become responsible for the due execution of all works."

All measurements of work, and all receipts of material, are to be attended by an officer of engineers, a clerk, and foreman of works. The two former are required to keep their respective measuring books, in which each is to make his separate computations.

This summary, taken from the official rules, shows the office of clerk of works to be subordinate and supplemental to that of the combatant officer of Royal Engineers, to be held by one intended to act in the dearth of officers, competent to perform minor but still responsible duties requiring technical attainments, and to have been resorted to as an agency less costly and more easily to be procured than the military officer of higher and more special attainments.

The organised system is, moreover, evidently intended to afford a reciprocal check throughout the whole working and detail. This is, no doubt, a sound and practical principle, but it is of no value unless it be applied in practice; nor does it appear necessary to resort to a complex or a civil agency in order to attain its adoption. Matters militarily organised are invariably checked, but it is by a board of officers, by the association together in specified duties of different ranks, or of different corps, or of different branches of the service. Civil agency is not necessary to this end.

In practice, however, the check is usually wanting. The officer of Engineers is often "absent at the station," that is, is not available in sufficient numbers to perform his allotted share in the system of regulated check, so that, be the result ever so innocuous, the clerk of works is generally unchecked. The *employé* actually made use of is the one who, of the two, is at the least the more open to the force of any temptation that may exist. This may be wholly unattended with evil; but if it be, it forcibly determines that the extent of the intended check is not necessary as well as not attained.

The qualifications prescribed for a clerk of works are "the strictest integrity, activity, and attention, and a full acquaintance with designing, building, artificer's work, and the qualities of building materials of every description. He should be competent to draw with neatness and accuracy plans, sections, and elevations, and be qualified to give

detailed working plans for the different parts of a building; he must understand thoroughly how to estimate and measure work of all kinds, be acquainted with book-keeping, and write a good hand."

These qualifications form, to the extent at which they aim, good and varied acquirements. If united in a high degree, they form valuable professional attainments; but this summary, which may be taken as the standard or ideal of a clerk of works, does not contain anything at variance with military service. Integrity, activity, and attention are necessary to the performance of all duty, but they are emphatically military qualities, and they are to be found as conspicuously in the higher ranks of non-commissioned officers of Royal Engineers as anywhere else. Full acquaintance with designing ought to be the necessary qualification of an officer of Engineers, and forms, as has been seen, the whole or main object of his training in the routine of professional duty. So also with regard to the principles and practice of building, and a general acquaintance with the qualities of building materials and the higher descriptions of drawing. That full knowledge of the minute details of building, and of artificers' work, and that intimate acquaintance with the various materials employed, which are essential to the perfect execution of work, can never, as a rule, be so thoroughly concentrated in any one class as they will be separately possessed by master tradesmen in the several branches that enter into the requirements of military service, and the position of a master tradesman of very high qualifications is entirely consistent with that of a non-commissioned officer of the higher grades.

Clerks, according to the regulations, are to be between twenty and forty years of age, to possess respectability of character, to write clearly, legibly, and quickly, with correct spelling and grammar, and to have a perfect knowledge of the first four rules of arithmetic, of Reduction, and the Rule of Three, of Vulgar and Decimal Fractions, and of Duodecimals. As to office work, they are to assist the clerks of works, whose time is to be rendered as available as possible for outdoor duty.

The correspondence of a large office, if that correspondence be necessarily large, or if the duties be confidential or important, ought to be under the charge of an officer; but if it consist only of the minor duties of clerks, or of what the Regulations term "mere office work," these duties clearly fall within the capacity of many non-commissioned officers, or even of men in the ranks.

So far as this civil element may have been resorted to from motives of economy, it can scarcely be said to have been eminently successful. Its cost is by no means insignificant. By reference to the army estimates 1864-5, it appears that there are 19 clerks of works, 83 clerks, 90 temporary foremen of works, &c., representing, with the various allowances, altogether an expenditure of about £74,183, besides rations equivalent to those of upwards of 100 men. An expenditure as nearly as possible three-fourths the amount voted for the whole existing companies of Royal Engineers, and which, with the additional sum of £3,394, expenses in the office of the Director of Works for surveyors, draftsmen, and clerks, amounts to upwards of 8 per cent. on the whole

votes for works and buildings for subsidiary and subordinate assistance, exclusive moreover of the proportion of the £125,055 for clerks in the War Office that may be employed on duties arising from the same votes, which amount for clerks only in the War Office is some £15,000 a year more than the cost of the 40 companies of engineers, and exactly one-sixth the entire expense for works and buildings of the whole imperial service at home and abroad.

Thus the regular employment of the officer of engineers, though carried on in all parts of the empire, brings him, unless he be attached to the little body of soldiers incorporated under the same name, everywhere alike into a round of duties, in the conduct of which he is associated with civil assistants, civil contractors, and civil labourers, in short, exclusively with civil life. He forms the sole, and he is often deemed the anomalous military, element of the life that surrounds him. Even if taste, liking, and zeal could in every instance rise superior to life-long habit, rule and circumstance, still it is obvious that the officer of engineers is in general placed at a disadvantage as impolitic as unfair as to the acquirement or practice of military aptitude and habit.

Impolitic, *because his military service is the essential object of his professional attainments.* He is liable to be summoned at any moment to duties that a soldier, animated by a soldier's spirit, only can perform. He may suddenly be called to be concerned in, or perhaps to conduct, the operations on which the safety of a fortress, the success of an expedition, or of a siege may wholly or in part depend. Unjust, because he is debarred from the attainment and practice of those qualifications that would enlarge his capacity for service, and from cultivating that aptitude and taste which most probably led him to enter upon a military life. The fulfilment of such aspirations he must, under present conditions, in general for ever forego.

In practice the extensive employment of civil agency is, however, productive of an injury more serious than any merely personal hardship or injustice.

The primary aim of the whole detail of the routine of duty is declared to be the training of the officer of engineers so that he shall, through personal and experimental conversancy with every branch of that detail, become perfectly fitted for the post of commanding engineer by the time he shall attain that position. Very frequently the junior officer is not under this immediate guidance and supervision by his commanding or senior officer, but is often called upon to furnish, as best he may, designs, plans and estimates for various services, and is ostensibly required to employ a degree of knowledge which his limited experience renders it, in fact, impossible he should possess; whilst, at the same time, the actual definition and subdivision of duties, laid down by authority, often puts it out of the power of his commanding officer to interfere at all with these duties in the course of their preparation, after he may have furnished his general instructions, until they are submitted to him in a state of comparative or absolute completion.* The commanding officer can then only transmit

* This is almost invariably the case at outpost stations where there is generally a very young officer, but an experienced clerk of works.

the documents he receives to the higher authority over himself, or return them, if absolutely necessary, for amendment to the junior officer, and so inevitably delay the service he is expected to forward; and, in fact, the junior officer has both been expected, and by circumstances forced, to appeal for professional direction or help not to his senior or commanding officer, but to his subordinate, the clerk of works, from whom, unless the strength of his own character have prevented it, he is more likely to have taken guidance also, than to have received assistance only. The work approved by the commanding engineer, that is to say, which has thus passed through his hands, undergoes a farther scrutiny under a superior authority, but by a civil revision as to the minutiæ of detail. In its lower stages this course is contrary to all military subordination, and at variance with the proper relations between the officer and the clerk of works. It can act favourably on neither one nor the other. Its practical effect also, is that the officer of engineers only has the opportunity of fully dealing with the whole details of his professional duty in all their minutiæ at a time when his experience and his youth are calculated to interfere, the one with the ability, and the other with the inclination of doing so with good effect and in good earnest. Throughout, that thorough conversancy and complete responsibility that might be otherwise obtained are frustrated. Whether the general qualifications of the clerk of works be good or bad, his technical attainments, if he have any experience, must necessarily be greater than those at first possessed by the young officer. Besides, if he be young or indolent, or conscious of deficiency, he may fall back with but slight risk of detection upon the technical knowledge of, and on the practical examination of the work wanted by the foremen of the very contractors to be employed in the eventual execution of the service under consideration. In point of fact, clerks of works do receive after their entrance into the service that very training at the hand and under the immediate supervision of their seniors, which the Regulations so pointedly prescribe for the officer of engineers. If exceptions take place to the course that has been described, it is owing to officers of Engineers taking upon themselves the duties of detail belonging to the clerk of works; but so contrary is the practice actually pursued to the official theory of the code of Regulations, that his doing so would not only not be sanctioned, but would under ordinary circumstances necessarily expose him to the censure of his superiors. Thus if the foregoing statements be accurate and admitted, the numerically strong, complex and very costly civil agency employed is not essentially necessary;—is needlessly expensive, and is calculated to frustrate rather than to foster that which is declared to be the aim and basis of the method of the entire prescribed system of duty; and if training for his future position in the manner therein laid down deserve the weight clearly attached to it by the Regulations, it were too sanguine to expect that its frequent complete negation in practice can have had no injurious effect in the instance of every officer who has risen to the position of commanding engineer without it. At the best, let them have remedied the consequences as they may, officers so circumstanced

have undoubtedly not had the advantages to which they were entitled and which the orders prescribed.

APPENDIX B.

The divergence between theory and practice in respect to the training of the younger officers of Engineers has been pointed out. So far as the object theoretically proposed can be met by any instrumentality it would be fulfilled by a military system. Were the minor divisions of Engineer commands abolished, and the current and special services as they arose allotted under the immediate orders of the Commanding Engineer, not only would a greater and direct responsibility be obtained, but the preparation of plans and estimates might readily be devolved on the junior officers under his immediate direction as laid down by the code of regulations; and, by entirely withdrawing clerks of works from the duties and offices of the younger officers, these would have only the legitimate assistance of approved non-commissioned officers, masters of trades.

During the continuance of the existing clerks of works, *whom it is proposed to promote in the same manner as now to the highest situations at present open to them*, they might with great advantage be attached to the offices of the Commanding Engineers charged with the duty of examining all the minutiæ of the details of services prepared by junior officers or by non-commissioned officers upon the instructions that had been given direct by the Commanding Engineer or his assisting officers. The younger officers would by this means necessarily become conversant with every branch of their duty, and that under the immediate direction and observation of their superior officers. Their qualifications and improvement would be daily tested, yet without needlessly encumbering the commanding officer with a burden of detail. As vacancies occurred in the establishment of clerks of works these duties should be performed by one or more officers of medium rank assisted by perfectly trained non-commissioned officers. The direct benefits to the service would be scarcely less considerable than those to the training of the younger officers. The services required might be performed more directly and with less back reference. *Waste labour*, which in *physical* matters is deemed the most severe of punishments, if not the most ingenious and cruel of tortures, would be greatly lessened. The multiplication of plans and documents, the copying and registering of correspondence and orders, rendered necessary by sub-divisional arrangements of duty, often at the same station, would be diminished, if not wholly abolished. By farther substituting for regulations which require the correspondence to be kept in books of "letters received" and "letters issued," a classification of correspondence according to station and subject, this simplifying may be much extended, and the information relating to any station or subject ascertained by simple perusal, instead of having to be "hunted up" by means of hieroglyphics referring through a multitude of ponderous volumes and perhaps

ingeniously elaborated to necessitate dependence on personal knowledge and individual inclination.

Similarly, by requiring perfect models or plans of every particular, and all information, properly classified and perfectly distinct, to be at *the actual working head-quarters* of every station, and nowhere else, it would always be known whence to obtain any information that might be required, and always practicable to obtain it without delay, and yet without multiform waste reproduction of the same matter.

This simplifying, and that is but another name for the combination of order, efficiency, and economy, might be usefully extended by consolidating the votes for the military constructive service, and abolishing the arbitrary distinctions of "fortifications," "barracks," and "store and other buildings," which compel a multiplication of the forms of estimate with all the accompanying papers, and which end only in obscuring the real military resources, requirements, and expenditure of any one post, and in making it next to impossible to collect them and view them in their merits as a whole. Another practical improvement over a figment often detrimental in practice might be gained by voting services absolutely, instead of conditionally on termination within the arbitrary period called "the financial year," whereby the gist of the whole matter, the actual execution of the work wanted, is often thrown into the most unsuitable season of the year, and contracted for and carried out under conditions unnecessarily disadvantageous, causing moreover needless and often perplexing labour in other words, useless expenses in supervision as well as in the contracts, for the time of its paid servants is the money of the State. It would be quite compatible with this proposal to limit the expenditure within the year as might be deemed requisite by considerations of finance. The evil arises from the practical work being subordinated to what may be likened to the convenience of the clerks taking stock, not from the fact of stock-taking.

In many respects the bases of military requirements are in a great measure constant; where this is the case at least the general arrangements may be grounded in common upon these requirements. For instance, the strength of a regiment of cavalry or infantry, or that of a battery of artillery, or of a company of Royal Engineers being determined, as well as the various items of accommodation that have to be provided in addition to the barrack room, such as shops, chapel, school, library, and recreation rooms, gymnasium, canteen, and the like, and the proportion of officers and staff, non-commissioned officers, and of married soldiers' quarters, the general arrangement and construction of a barrack should in each case be uniformly based on these constant requirements, which ought to be clearly defined in one consolidated regulation. Such a construction must be worked, as it were, outwards and upwards, not pressed by an arbitrary necessity, such as too small a space of ground, or the vote of but one-half the necessary money into conditions not to be reconciled. For example, the barrack-room ought to be determined not from an outward dimension, but by addition of its contents, from the dimension of the barrack bedstead, the space to be left between them, the air

to be breathed per man, the nature of the stove or fire-place, the best position for the arms, for shelves and accoutrement pins, the number of men it may be deemed on the whole most judicious to place in one room, and the effect of the position of door and windows on these particulars. The detail of the several buildings having been deduced from similar considerations, their relative position one to another, and to the parade, the drill or exercising ground has next to be determined.

It is obviously unnecessary to employ a numerous and expensive staff in repeatedly meeting these wants from limited experience and confined resources. Indeed many of the elements are necessarily arbitrarily fixed, and can only be determined by the highest authority. Under the existing system, the result of all experience must be concentrated at the War Office, and should long ago have caused the ideals of all such services to be, so to speak, stereotypes to be only so far modified, as might be necessary or beneficial from local causes. These modifications arising from intimate local knowledge, would be the proper subjects of scrutiny by higher authority, both as to conception and proposed execution; but it should be unmistakeably open to all commanding officers to bring to the notice of the superior authorities any suggestion they might deem an improvement deserving such consideration.

It is obvious, that from the aggregate of such designs as have been described, any one or more of the several parts that might be separately required, might be readily adopted; that is to say, precisely the same principles are applicable to the component parts of a barrack, and to all frequently repeated services grounded upon constant requirements.

Annexed are forms for the employment of military labour. They give a complete diary and check-book without any repetition of the services performed or of the nominal roll in the daily distribution. They comprise fully everything that can be required, and by the "Abstract" in the "Diary of Services in Execution," become the basis of a record or expense ledger, made by simple extract, which would show the expenditure for any given time on every building, or particular part or class of buildings, or on any special service, or on any post, station or establishment. They have been framed to meet the most intricate case (so far as mere book-keeping is concerned), that of maintenance by minor repairs executed on requisitions generally containing many items and often occupying only part of a day in execution. The same forms answer for all other cases, but fewer entries are necessary and fewer distinguishing marks among the entries.

Form I. The "Diary of Services in Execution," shows the service required in column I, specifying in its subdivisions A, B, and C, the locality or name of the work or building, the description of the construction or repair required, and the date of the service ordered.

Column II gives the item and vote or estimate to which the service is chargeable:

FORM 1.—Diary of

Date of Execution.		Requisition or Authority.		SERVICES.			Chargeable to		DETAIL as EXECUTED by			
									Materials.			
From	To	No. of Requisition.	Item on Requisition.	Locality or Name of Work or Building	Description of Construction or Repair required.	Date when ordered.	Vote or Estimate.	Item of ditto.	Nature, Description, and Quantity.	Cost. £	s	d.
V		III		A	B	C	II		a	A	b	

Services in Execution.

th Company Royal Engineers.
or
th Company th Regiment.

ABSTRACT.

Names or References by whom executed.	Labour. No. of Men. Time employed.	Labour. Rates of Pay.	Total of Materials and Labour. £ s. d.	Cost per Detail at Contract Prices. £ s. d.	Difference. + or − as Executed. £ s. d.	Remarks.	Work, Service, or Building.	Amount. £ s. d.

IV B c Cd d D VI VII VIII A B IX

Column III, the requisition and its item in cases that the service is one performed on requisition.

These columns should be filled in immediately on the receipt of any order for the execution of a service; and are merely clerk's work requiring no technical knowledge.

Column IV shows by its various subdivisions A, a b, B, C, c d, and D the materials consumed in the execution of the service and their cost, by whom each part has been executed, and the cost of the labour expended at the regulated rates of pay, as well as the total cost of both material and labour. With exception of this last subdivision, which is merely the addition of other two, this column, as well as columns V, VI, and VIII, must be filled in by those entrusted with the superintendence and execution of the works.

Column V gives the date from the beginning to the end of the execution of a service.

Column VI, its cost as estimated at contract rates by civil labour.

Column VII, the difference above or below that estimate, of the actual execution of the work by military labour.

Column VIII is for remarks.

Column IX (A B) gives an abstract of all work done and of its cost, from which a perfectly accurate record may be kept (without any further trouble than that of noting it) of the expense incurred according to any classification that may at any time be wanted, however arbitrary; such as commanding officers, field officers, and officers, quarters, men's or married soldiers quarters, chapel, schools, libraries, recreation rooms, canteens, or gymnasia, walls, brickwork, masonry or wood, of boundaries or of buildings; roofs, slate, felt, or iron; stoves, grates, drains, roads, fences or what not, almost without end. One form and one entry contains the whole; nor is any other precaution necessary to its use than to avoid crowding the entries in column I in order that sufficient space may be left for the parts under A and B of column IV.

Form II. The "Weekly Check Book and Diary of Daily Distribution," the former framed to meet the regulation by which military working pay lists are made out weekly, and, with the latter, showing where and on what services each man is employed each day.

Column I gives the nominal roll, and after the entry of the non-commissioned officers, should be arranged by trades. Its subdivisions give the names, trades, rank, and regimental number of each man.

Column II enumerates the services in progress during the week, to each of which is given in the subdivision B of that column a distinguishing number or mark, which used in the appropriate part of the column (III) of the days of the week, shows the service on which the man was employed opposite to whose name it is placed on the day under which it appears. When a man has been employed only for part of a day, the fractional part placed under the distinguishing mark denotes the proportion of the day for which he has been employed on the service, which is indicated by the distinguishing mark or number. When he has been on more than one service in a day, the several distinguishing marks, with the proper proportion under each, will show

his whole employment for the day. Subdivision C of this column shows to what item and estimate each service is to be charged.

Column III contains the days of the week to be filled in as described in treating of column II. It also contains under each day of the week a subdivision for the initials of the superintendents. This initial, if unaccompanied by remark, inserted in the column for that purpose, is the certificate of him whose initial it is, that he is satisfied both with the quantity and the quality of the work performed by all those under his charge and devolves the responsibility to that effect upon him. By this simple method a certificate and report are daily obtained extending from the non-commissioned officer in charge of a squad or of any detached piece of work, or of any particular branch of work, through the several master tradesmen up to the officers in charge of works, involving a direct acknowledgment of personal responsibility throughout every portion of the work.

Column IV is abstracted at the end of the week, and shows the amount to which each man has become entitled, according to the days he has been employed and the rate at which he is to be paid per day.

It is obvious that task-work can be registered by the same means, showing in days, the value of the work performed.

Column V is for remarks by the different grades of superintendents as may prove necessary.

Column VI is for the amounts and items to which the whole expenditure of the week has been chargeable, showing the amount per item and per man. It must contain as many subdivisions as there are separate items of expenditure in actual progress during the week. This can be sufficiently foreseen to prevent, by an ample allowance, the necessity for any frequent repetition of the heading. Under each subdivision is brought out opposite to each man's name the proportion of his earnings as it is chargeable according to the heading of the subdivisions.

Column VII gives the account authorised for each service, and the mark of reference to the authority.

Column VIII is for the amounts expended on each service, both during the week, and total up to date.

Columns IV, VI, VII and VIII, are clerks' work. The entries on the lines in columns II, VII, and VIII, must correspond with one another, and those in columns I, III, IV, and VI; but the entries in the two sets of columns are quite independent of each other as to the space they occupy.

Form II.—Weekly Check Book and

NOMINAL ROLL.				DAYS EMPLOYED.												ACCOUNT for the WEEK.					Remarks.
Regimental Number.	Rank.	Names (after the Non-Commissioned Officers arranged by Trades.)	Trade	Monday		Tuesday.		Wednesday.		Thursday.		Friday.		Saturday.		Total Number of Days.	Rate per Day.	Amount.			
				Employed.	Initials of Inspection.	Employed.	Initials of Inspection.	Employed.	Initials of Inspection.	Employed.	Initials of Inspection.	Employed.	Initials of Inspection.	Employed.	Initials of Inspection.			£	s.	d.	
		Date 18																For the Week			
I				III												IV					V

Diary of Daily Distribution.

SERVICES in PROGRESS.			AMOUNTS and ITEMS to which the employment of each man is chargeable during the week.												Authority quoting the Reference of the authority and the amount authorised.	Amount expended					
Distinguishing Mark or Number to be used in the Column of Days employed.	Description (sufficient for Identification.)	Chargeable to.	Vote.			A. E. 18 ·/. It.			A. E. 18 ·/. It.			A. E. 18 ·/. It.				During the Week.			Total up to Date.		
			£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
	from the	th						to the			th				18						
B	A																				
II			VI												VII	VIII					

The advantages of these forms are the completeness and succinctness with which every particle of information connected with the execution of a service is entered and recorded without any repetition of writing, the consequent saving of time and of money in useless office expenditure, the complete chain of report and responsibility obtained in like manner, whilst all the information connected with the execution of every service is minutely recorded, ready and plain at a glance whenever it may be required for reference. The daily distribution for instance may be ready with the first morning parade, the distribution as appointed being entered in pencil and filled in with ink according to the actual event of the day, on the return from work.

The arrangements for the next day are also made at that time; the several officers, or non-commissioned officers in charge of works, or parties attending for that purpose at the engineer office, and receiving from the directing officer instructions already prepared according to the orders received during the day, as well as orders of delivery from the store charge for any material that will be required for the services in hand or to be done.

These delivery orders retained by the issuer become his vouchers to the commanding officer for the material thereon specified.

The receipt, custody, and issue of materials may be reduced to a very simple routine. The requirements of new or special services can occasion no difficulty. The materials required for these, necessarily appear in the estimates on which they are sanctioned, and have only to be ordered, received, and taken on charge before the work is ordered to be executed; those for minor services can be provided for without any delay by an order on the contractor for the probable consumption for a month, taking into consideration the stock that may be on hand.

By this means both delay in the execution of a service and too great, troublesome, or responsible a store charge are alike avoided. The receipts of material would be so regular and comparatively infrequent that all material so received could be strictly measured and examined as to quality by the properly appointed officers according to the intention of the present regulations, now often, as has been stated, neglected or impossible in practice.

The custody of materials is provided for, by the appointment of an officer or non-commissioned officer according to the extent of the charge.

Evening Meeting.

Monday, April 25th, 1864.

Captain E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

NAME of MEMBER who joined the Institution between the 18th and 25th April, 1864.

ANNUAL.

Mayo, J. H., Lieutenant West Norfolk Militia. 1*l.*

ON THE CONSTRUCTION, MODE OF APPLICATION, AND USE OF HIND-WHEELS: BEING A NEW FORM OF PADDLE-WHEELS WORKING UNDER THE COUNTERS.

By Major J. Scott Phillips, late H.M. Bengal Artillery.

Ladies and Gentlemen,—It is with great deference to the opinions of the Members of the Royal United Service Institution, as well as to the opinions of the scientific friends who have honoured me by their presence, that I venture to address this meeting, and attempt to bring forward a naval propeller, for which I solicit your favourable attention, while I endeavour to set forth its construction, its mode of application, and its claims for further notice. And as you have so kindly granted to me this favourable opportunity, I will not further preclude that which I have to say concerning this propeller, save merely to observe, that I have been making studies and experiments on the subject of propulsion for upwards of two years past; and were I not conscious of having devoted much time and pains to the matter in hand, I should not have ventured to appear before you. Before proceeding with my subject, I will just show the action of the common paddle-wheel by means of the model in the trough of water, seven feet long by two wide, before you, in order that you may have a clear view of the quantity of water which it lifts, and thereby also form some estimate of the power lost on entry; and though Morgan's patent feathering-wheel lifts very much less water, it loses some power

by the friction of its governing rods and their eccentric, while of course, like the common wheel, it cannot be carried out of the way of danger from shot and waves, or be applied with equal advantage to a sailing vessel. And I will mention that in the model fitted with *hind-wheels*, of similar diameter to the common midship-wheels before you, the hind-wheels (such being the most appropriate name for my wheels as will appear in the course of this paper) beat the common wheels by seven per cent. in speed, though I consider that as yet I have not been able to study ship-building so as to give to the hind-wheels their full advantages. After this necessary digression I return to the propellers fitted on the hind-wheels, which I wish to recommend, and which are made like the model which I hold in my hand, (Plate XIX, Fig. 4,) formed either by casting, or by fastening together two sheets of metal cut upon curves, to which I will presently allude, and folded as it were upon a certain angle, till the shape produced resembles that of a deer's or hind's foot.

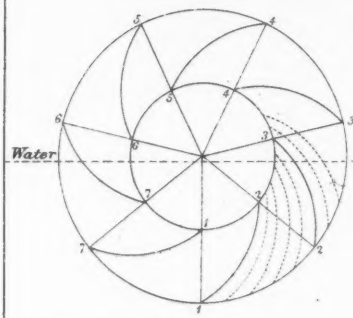
In fact, the forward curved angle, if I may so express myself, of this propeller, is formed on a line which after marking the extreme circuit of the proposed wheel at seven equidistant points all round, and, as in Fig. 1, marking off the subdivisional points of seven radii drawn to the said seven points, will connect the semi-radial with the circumferential points; and on such points by such a line or lines, seven like propellers being affixed, (for I have found by experiment that the proper number of floats is exactly seven, that number giving a clear beat into unbroken water for each successive float) a wheel is formed such as I now exhibit, which cannot lift water—a fact of which you can judge most assuredly, if you will but kindly attend while I move the sheet of zinc cut to represent the inner flange of a hoof-shaped float over the face of the diagram (Fig. 1), which, representing a wheel with its proper water-line or dip, enables me to show that the front curve of the hoof-shaped float is so framed as by the said sheet of zinc, that this curve, and in fact the whole propelling surface, comes out of the water at very nearly, if not absolutely a right angle to the water-line. Now there being no other angle but the front angle in my propelling floats, I trust I have decidedly cleared my great leading fact, namely, that this propeller having no opposition at entry, its entry being covered, as you see, by the front of the well in which it works (see Diagram, Fig. 3), has, above all, no lift or breakwater on coming out, and this I will exemplify before your eyes by causing the hind-wheels to revolve at speed.

And now I would ask your patience while I endeavour to run through the preparatory subject of the water lines beneath and around the stern of a swiftly-progressing vessel.

Not to dwell upon the mode of that dispersion of the waters which is necessary to make way for a vessel at speed, I consider those waters as pushed aside and virtually dispersed to such a degree that they cannot furnish the necessary supply to fill the space beneath the stern; and therefore that space must mainly be supplied by waters rising up from underneath, of which we have what I venture to think is a very strong proof in the fact of chips and straws following a round-sterned

Fig. 1.

Principles of Construction



Curves for front edges of hoof propellers (or Floats) struck from inner Circle at the 7 Points of inter-section as by Points $\frac{1}{2}$. $\frac{2}{3}$. $\frac{2}{4}$. $\frac{3}{5}$ *&c.*

The Dotted Curves show the extreme angle at which the Floats quit the Water, demonstrating the impossibility of their having any lift.

Fig. 2.

Sketch of Backwater as seen ris
under the Stern of a Section of
Connector Steamer at Anchor
four knot Tide

Fig. 3.

Rough Sketch, shewing by actual Experiments the general form of the inrush from both sides and the uprise from beneath in a Well prepared for a hind Wheel when a Vessel is rapidly drawn through the Water

This Diagram will aid the conception of how it is that fluid Wheels however fast they may be driven will always obtain a full supply of Water, which is not the case with all other Wheels as hitherto used.

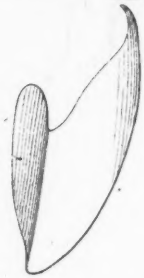
. 2.
er as seen rising
f a Section of the
r at Anchor in a
t Tide

Foot of Cormorant
Standing

Fig. 4.

Foot of Cormorant
Swimming.

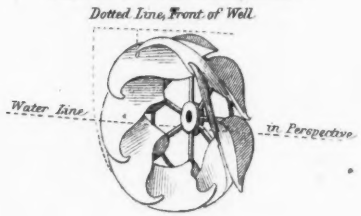
The form and Action of the Cormorants foot in Swimming was noted at the Zoological Gardens. April 8th 1864.



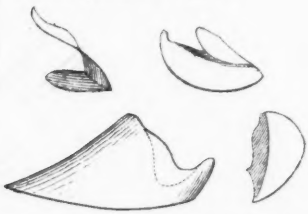
Hoof Float
Propeller

Hoof Float / Side View.

Fig. 5.
Side View of Wheel in Perspective.



Hoof Floats or Propellers



An Average Shaped Hinds or Deers Foot

J.R.Johbms.

vessel when at speed, pressed close against the stern by reason of that sudden welling up of waters from below, of which I have just spoken. Indeed, we may consider that of necessity the space astern between the side currents of displacement, will certainly in the largest measure be filled up by waters from underneath; because the beam in a vessel built for skimming rather than ploughing the deep, being equal to more than three times the draught, the side currents cannot close in as fast as the lower waters must rise; those waters also rising the faster, because of the pressure of the ocean increasing in proportion to the depth of the space requiring to be filled.

In speaking thus, I would not be understood as attempting to do more than merely indicate a general view, which will admit of great modifications, as by the stern build of vessels and the point and depth of outbreak of the wheels. But when we may be so happy as to see an experiment made with a vessel of 80 or 100 tons, a canal tug (such as could be built and fitted complete for £1,200) or an Indian river cargo boat, we shall be enabled to look between the spokes of a revolving wheel to "discover the channels of waters," to see distinctly how the inner or breakwater rises, the form which it assumes at different rates of speed, and so obtain more decided ideas upon absolute demonstration.

I have, however, been able to experimentalize in some degree, by placing a tin box without a lid and left open, on one of the smaller sides, in a strong current of water. For on sinking the box one-fourth of its depth, it became emptied of water, while the forms of the rising under-current, and the two side currents became clearly visible. And I would also draw attention to the drawing which I exhibit (Fig. 2), showing the rise and the side currents astern of a section of Mr. MacSweeny's ingenious connector steam-ship, when anchored in a four-knot tide. There you will perceive (though the illustration is an extreme one) the side currents only joining one another about 40 feet astern; while between them arises a tumultuous welling up of waters with eccentric curves; half of which rush towards the vessel, and dividing against it form two side eddies, which presently retire in a series of eddies to the general wake. These illustrations it may be of some use to consider, and it will then, if this theory be acceptable, be evident that there will always be under the quarter of any vessel in motion, and influenced by the vessel's build, a certain general line which may be termed the line of contact between the rising waters and those which are closing in; outside of which line the current is passing in swift curves to form the wake, and inside of which the waters from beneath are tumultuously welling up and rushing in a continued series of eccentric curves, part more or less against the vessel's stern, part to meet the side currents, and part astern into the general wake.

And here my propeller, may I say it, naturally drops in. Feathering as it were smoothly down, the outer flange of my hoof-shaped float gathers water from the outer current, and then embraces with full scope the waters of the inner rise, a point to which I earnestly beg your attention, especially in connection with the peculiar form of the

wells in which the wheels work as shown in diagram (Fig. 3); and as the propellers in swift succession meet with their curves the swelling waters of that inner rise, so they obtain in some degree the fulcrum of opposing waters, instead of driving, as does the screw amid waters, passing through it; or, as the midship paddle-wheels, through waters in some measure slipping past them. And now, if you will kindly observe, the propellers are so arranged, and the wheels carrying them are so placed, as to be thoroughly shielded on entry, and then so as to break out from the wells in which they act, feathering smoothly in to their work, at the precise point of advantage to make the most of the rising back and side water; while, as the propellers aid each other, they so keep back the waters that they have not only their inside gathering of waters to aid their fulcrum, but also the pressure of the waters heaped up from below. Nevertheless, the heaping or driving back does not affect the clear exit of the propellers (or floats), since owing to the mode in which each propeller is lifted out of the water, they do not lift water, leastwise (for these are not of perfect manufacture) but a very little; while, I believe, that by giving a slight twist inwards, as by the shape of a natural hind hoof (Fig. 5.); even this small amount may be obviated, and the propellers come out emptied to the smallest drop.

These propellers, however, have also, as I conceive, an additional recommendation when driven at high speed, which I may best exhibit after suggesting the query as to why it is that, while we can travel 60 miles by land in an hour, we cannot get a speed of more than 20 by water? seeing that we have an incompressible fluid to deal with, though contrasted with solid metal?

Now, the theory has been suggested to my mind, that as the incompressible waters must require some average time to allow of their particles acting against each other, and so of the masses being moved; it is but a question of time versus matter or driving speed, to convert the moveable yet incompressible fluid into practical solid; and, therefore, if we can construct propellers so strong, and so perfect, as to contain merely the elements of propulsion at a certain angle, with a perfect entry and no lift; and if such propellers can be formed to grip—I say to grip—the fluid for so long a time, and no more than is precisely needed; then, if we drive these propellers at a speed exceeding the measure of time which is required to set the particles composing water in motion, we shall drive as against a solid, and obtain transcendent results with corresponding benefits.

In support of this view, allow me to quote the able Editor of *The Engineer*, who writes concerning the benefit of quick driving under date February 12, 1864, as follows: "It may yet be found that "light quick working engines are superior in all respects to the vast "masses of machinery now placed in our vessels of war. It is per- "fectly well known that small engines, working at high pressure and "at quick speed, have far the most power for their weight. They "are too by far the best adapted for economical expansive working, a "fact proved by locomotive practice. With improved engines of "greatly diminished weight, and driven, say at 600 feet of piston

"per minute, and with twin screws (for which I would say, read "wheels), a great increase of effective power might be introduced "into our ships of war, and that, with a decreased weight of machinery "and decreased consumption of coal."

And so, I venture to think that, quick driving—if you only have but a proper machine—is the thing to be aimed at; and I suggest the theory that, with quick driving, and with my hoof-shaped floats, a positive grip may be obtained, which will avoid slip, and enable us over the waters to emulate the railway engines on the land.

An ordinary paddle float cannot grip the water, cannot be driven beyond a certain speed, but it forthwith lifts an enormous load of water, or scoops off the surface water, and is endangered by its own action, or actually loses power.*

The best screw likewise has no grip, the waters are passing off its surfaces continuously, while in both screw and paddle the driving surface power increases only as the square, while the hoof power increases in a measure as the cube.

For the propeller or float, which I have been permitted to bring before you (Figs. 4 and 5), containing, I repeat, the pure and simple elements of propulsion, without drawback, has, owing to the gradual contraction of the hoof shape (a most material point) a grip; at high speed will have a powerful grip, aided by strong internal friction, when, at a certain, and that a beneficial angle, slightly downwards, and I do hope that I may carry the consent of some present with me, when I beg to affirm, that were this but the merest theory, such theory would be worthy of a trial on a large scale; in the hope, if but in the hope, to grasp such transcendent advantages as a realization would secure.

To the gentlemen present I need not dwell upon the combined strength and lightness of the wheels before you, or point out that the whole working strain is thrown upon the inner-angle of each propeller in lines perpendicular to the radii of the wheels. And I will only, ere passing on to a brief summary of the advantages to be gained by their use, pause to note that these propellers have besides other analogies, a strict analogy with the propeller of the most powerful swimmer and diver of the web-footed tribes. I mean the cormorant, which, with his triple-webbed foot, overtakes the fishes with their finny tails.

In these feet I have found, by actual inspection, at the Zoological Gardens, on the 8th of this month, and in clear water, that when the

* Three days after the reading of this paper, having obtained a spring of greatly increased power, it was found that, on trial, the common wheels were whirled round so rapidly that, having scooped out a hollow, they merely produced a scattering of water aft, the vessel making no progress in the water, because the wheel-floats being parallel to one another and set on at right angles to the line of progress, could not get the needful supply of water to enable them to propel the vessel; while the hoof-shaped floats, entering without loss of power, being put on at consecutive oblique angles to the line of progress, supplied with water from within, and from without, and from underneath, and gripping the water, drove exceedingly well, the wheels revolving at a proper speed, and lifting no water as they revolved. Hence it is concluded that the discovery, as set forth, is now established and complete.—J. S. P.

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bird is striking out, the inner web, as shewn in the Plate, of a triple-webbed foot, is thrown back, and the outer-webs are also thrown back, until the foot obtains the form of my propeller; and then the cormorant, with instantaneous strokes, amid the waters, drives as against a solid, and cleaves the waters like a flash of lightning.*

And, now, allow me to narrate the advantages looked for from the use of hind-wheels, throwing in such remarks as each may call for:

1stly. Being of strong construction, the force of stroke falling on the inner angle of each propeller, and being sheltered from shot and waves, they will scarcely ever need repairs, cannot get fouled, and will work with perfect smoothness. Dipping deeper than the common wheels, they are not so liable to be alternately rolled out and unduly immersed.

2ndly. If found needful, though I doubt the necessity, larger wheels can be carried than is usual, because these wheels dip so much deeper than the midship wheels now used, and can be made to sweep the full draught of a ship. Indeed, I have found by experiments with the model and wheels before you, that I could drive the same seven per cent. faster with the hind-wheels, than with the common wheels; the machinery giving out its power in one-third less time, while I am entitled if I choose to use wheels one-sixth larger than the common wheels, if it is not found that small wheels rapidly driven give the best results. I shall thus bring my driving surface fully up to that of the largest midship-wheels (the large seven-inch wheels before you making equal revolutions with the six-inch paddle-wheels), while yet I retain the great superiority of easy driving at the highest speed, or any speed whatever, because, as afore-shown, my hoof-shaped floats contain the pure and simple elements of propulsion, without resistance on entry or lift on exit. The common wheels lift more and more water the faster they revolve; my hind-wheels have no lift, and therefore they excel.†

3rdly. Hind-wheels give, of necessity, a very powerful steerage, because they send aft two columns of water, one upon each side of the rudder, which also meeting aft, destroy each others ripple, thus making tugs so fitted, peculiarly suitable for canal work. Worked with a pair of horizontal engines, each distinct from the other, but with a power of coupling them in long distances, no rudder will be absolutely needed, and hind-wheels will turn a vessel on its centre even better than do the twin-screws; while these last require a greater depth of water than do the hind-wheels.

4thly. They will enable us to use vessels of very light draught, instead of 20, 26, 22, 18 feet, they will enable the heaviest guns to be carried at 16, 12 feet, with buoyant, steady swiftness. In fact, all vessels will now be constructed to skim the waters rather than to plough

* At this stage of the lecture the action of the hind wheels, with wheels of 7 inch diameter, were shown in water.—J. S. P.

† H.M.S. ship "Salamis," October, 1863, could not use full boiler power to advantage with Morgan's feathering wheels, the vessel being found to go fastest with but half-power.—J. S. P.

deep; a great gain, indeed, for with increased beam, and a long fore-foot, and great swiftness, increased seaworthiness will be obtained, and that in many points, such as wear and tear, pitching, straining, tossing, and rolling, &c., on which it is not needful for me now to dwell.

5thly. The backing power for suddenly bringing up at speed will, I think, be found to be very good, and amply sufficient to back a ram off if required, which I doubt, after the delivery of an overwhelming stroke.

6thly. They give power to run upon an even keel to the diminishing of loss by friction, requiring even less draught of water than do the present highly approved twin-screws.

7th and lastly. They can be screened in a very considerable measure below the water line from side shots, by shields of double strength, for the breadth of the vessel between the wheels will give ample buoyancy to her stern, and while claiming a great superiority of speed and steerage, they can always drive a ship direct upon an enemy, so as only to expose the bows to glancing shots, a matter of imperative necessity, as the guns continue to triumph over armour-plates. Our present deep rams, driving between close jamming walls of water, will be able to inflict little or no damage upon a flying steamer, their speed being so little superior if at all, while to our grief, as Britons, we have to lament that rams will be formidable to sailing merchantmen, unless we can secure by means of hind-wheels, a vast superiority of speed for all our vessels. With rams of light draught and great speed, gunnery may be defied. The ship magnificently propelled will be its own self-contained projectile, the be-all and the end-all for itself and others. We shall "pursue our enemies and overtake them, and turn not again till we have consumed them."

Of the twin-screw system I will only further notice, what all will probably have observed, namely, the larger continuous driving surface of the hind-wheels, and their direct action as opposed to indirect.

In conclusion, I have to perform a certain duty, and to ask for your kind, your friendly consideration, if I may so speak, while I endeavour to discharge it. We all know that it is considered a mean thing for a man to borrow his ideas from other men's books, and after working them to his own purposes, bring them forth as if original, as if his own. Therefore, I have to render honour where alone it is due; and am as truly constrained by common honesty as I am by other feelings, to tell you that I obtained the propellers before you from the Bible, as if I had obtained them by reading in the book or books of man.

It were too long to narrate how I first got the idea of the shape of a calve's foot as a naval propeller; though strange possibly for me to say, and you to hear, I got it from the Bible. And with wheels like those before you, modelled from a calve's foot, I drove a boat (in the presence of three witnesses) 22 × 5 feet beam, with two pairs of wheels, the other pair being common wheels, and both pairs of 4 feet diameter—I say I drove this boat 300 feet in 41 seconds (5 miles an hour) with two young men working, as against

the performance by the common wheel of the same distances in 57·4 seconds—41″ to 57·4″— in one-third less time.

Having achieved thus much, I thought that it would gladly be taken up, and lost a whole year in trying to have it so done. But failing, I took up the idea of prolonging the calve's foot, to suit after or hind-wheels.

While protracting the same on paper, my attention was drawn to several passages in Scripture; one in the Second Book of Samuel, one in Micah, one in Habbakuk; but especially to the 33rd verse of the 18th Psalm, where, describing the making of war, it is written, "it is God that girdeth me with strength, and maketh my way perfect. He maketh my feet like hinds, and setteth me upon mine high places." While the passage in Micah reads, "Arise, and thresh, O daughter of Zion (by which I think Great Britain is meant) for I will make thy horn iron, and I will make thy hoofs brass, and thou shalt beat in pieces many people."

Accordingly, having made my drawing, I took it to the British Museum, and found that I had actually, without knowing it, drawn the shape of a hind's foot. And applying that shape as a propeller, I have found that the more correctly I worked out the hind's-foot shape, the better my wheel became.

The greater the speed at which they are driven, the more decidedly their power and action are developed, in contradistinction to all other paddle wheels; and the direct action and driving surface of these hind-wheels, place them at once beyond all competition by any screw or screws.

So then I have, in conclusion, three analogies in order; namely, mechanical aptitude, for as an engineer said to me, "by all the rules "of mechanics, your wheels ought to be a great success." Next, I have the analogy of the cormorant's foot, according to natural history. And, thirdly, I have that literalism of the word of "The Lord of Hosts," alas! too much neglected, or even derided in these days, but to myself, I must confess, a source of practical comfort, of instruction, and, I hope, unbounded confidence. And I do look forward, I confidently avow, to the time when every steamer that leaves our River Thames, that river of strength, will go smoothly flashing through its waters driven by hind-wheels, fitted with hind's feet, and "Walk the waters like a thing of life."

While for the present, conscious that my wheels, or at least my mode of placing and adapting them to the lines of a vessel, may admit of great improvement, I do rather hope to obtain some assistance towards that end from any comments which my statements may evoke.

Gentlemen, I have to thank you for the kindness with which you have listened to so humble an amateur as myself, and I beg to offer my best thanks to the President and to the Vice-President in particular of this evening, and to the members of this Royal Institution, for affording to me the opportunity of bringing this new form of paddle-wheels working under the counters before a discerning audience.

Dr. CROFT: If it may be permitted to make a remark as the inventor of what I call screw-paddles, I should like to know how Major Phillips overcomes the back lift? *If he is enabled to do that, I should be inclined to look upon his as a very valuable invention.

The CHAIRMAN: This would exhibit (pointing to the model in the water) whether there is any lift. Perhaps you will explain what you mean by your screw-paddles?

Dr. CROFT: I don't know whether I should be in order: if you will allow me to offer an explanation, I should be very happy to do so (producing a model).

Major PHILLIPS: I have put this pair of wheels, having straight-lined hoofs on for convenience sake. I shall be very happy indeed, if there is time to put this pair on (showing, as I consider it is a better pair); because, though the wheels are smaller, the hoofs have their angle lines curved.

The CHAIRMAN: I suppose, substantially, they are pretty much the same.

Major PHILLIPS: No, they are not quite, because of the difference in the angle lines; then again, the larger you make these wheels in reference to the dip, the less and less water they raise, and the better angle they go out at.

Dr. CROFT: I should like to see it on a larger scale, because we could then compare the results better.

Mr. BARRASS: This seems to be a very good thing; there is one point I should like to mention, the author seems to make a point in dividing the paddle into seven equal divisions, with a view of securing one float to enter the water at the same time as the float on the other side is rising.

Major PHILLIPS: I am thankful to Mr. Barrass, for putting this forward, because it will enable me to clear up the difficulty. When I said that under this system there was always one float just entering, one working and one just leaving, I see from what you say, that this needs explanation. It is not so; that is to say, it is not so when the vessel is perfectly at rest, and before the well is cleared out; and, therefore, it is not until the well is cleared out, that the hoofs get into their full action. But of course, with any power on, the well is immediately cleared out; and then the action goes on with one hoof just entering, one full in and one just leaving. When the well is cleared down to that point (showing the lowest point of the well) you have one coming in in vacuo all the way. This one (pointing to the second hoof below the water line) is in full work—has full grip upon the condensed water, which is coming up from underneath instead of working in water rushing through it, as the screw does; and the third hoof is just coming out. In the trial of the twin-screws, mentioned to-day in the *Times*, they made 300 revolutions and only ran six miles an hour. Seeing that the experiment was deemed a great success, I was perfectly astonished to find only that result of speed; but I am not at all astonished when I consider that screws have to wabble amid waters which are rushing through them.

Mr. BARRASS: With respect to the double screw, do you propose to make your propellers as efficient as the double screw for manœuvering purposes? Do you have one shaft?

Major PHILLIPS: No; I use them with separate shafts, but I give them an arrangement by which you make the two shafts into one for purposes of long voyages. I arrange them so that they can work just as the twin-screws do with independent engines.

Mr. BARRASS: I simply asked the question, because you did not name it in the paper.

Major PHILLIPS: I have a sketch here which shows that. It is a drawing for an Indian river boat, of a hundred tons, in which I have drawn in two separate engines.

The CHAIRMAN: I am sure we are very much indebted to Major Scott Phillips for the introduction of this subject to the meeting. I think that without doubt, it is a decided improvement. I have long thought myself of adapting some form of float that would enter the water without violence, and without a shock, and would not raise the water; that would be a very desirable thing. Of course we have seen that

* Dr Croft did not enter the lecture-room till after Major Phillips had shown that there could be no lift of backwater, as by Diagram Fig. I.

in screws there is a very considerable loss of power: you drive them at a great rate, and there is a great consumption of coal. You get a greater speed no doubt, and under certain circumstances a considerable advantage; but, taking it on the whole, there is a very great disadvantage arising out of the consumption of coal which is necessary, and when you come to head-winds, there is always a great consumption of coal without any corresponding result. I don't think that will occur here while under similar circumstances in smooth water. I think there would be a greater result. This plan has decided advantages over the side paddle-wheel, and it approximates more to the twin-screw. It is of course a question only to be determined by experiment, as to whether it will give greater results than the twin-screw. No doubt you can get a greater suface here, but all paddles have this one disadvantage, this, perhaps, less than any other, that they are immediately affected by the alterations of draught; that is to say, as you consume your coal, you lighten your vessel, and as you lighten the vessel you lessen the dip of your wheels, and the consequence is your engines run away with your wheels, and there is a loss of power. On the other hand, if you so adjust your paddle-wheels that they give the best results when they are very deep, they lose power accordingly as they get lighter, or *vice versâ*. If you arrange them so as to have the best effect when the vessel is light, you have to contend with the disadvantage of heavy draught. I think alterations in draught will not make very much difference with this plan. I think they will be nearly as effective with a deep draught as with light draught, which is just what occurs in the screw. It seems in the screw, that the deeper the vessel is, notwithstanding the greater weight, the greater is the effect, because you get it into more solid water,—so you will have here. I quite agree with what Major Phillips says with respect to the water coming up from below. Again I think that experiments with larger vessels will give greater results than those mentioned arising out of this fact, that the larger the vessel is, the greater is the column of water to press the water under the paddles. The more solid the water is, and the deeper the immersion of the wheels arising from the greater column of water, so the effect will be increased.

As we have another paper to read, I will not occupy any more time. Will you allow me to offer your thanks to Major Phillips for his very interesting paper? He has gone into quite a new field, and it does him more credit inasmuch as it is not his profession, and he has not had the advantage which many of us have had.

Major PHILLIPS: I beg to return my best thanks for your kind reception of my paper, and that, not only by all present, but by the members of the naval profession in particular.

MONT STORM'S SYSTEM OF BREECH-LOADING.

Contributed by Mr. F. A. BRAENDLIN, and read by CHARLES PHELPS, Esq.

GENTLEMEN,—At the request of several gentlemen much interested in the recent improvements of small arms, I am induced to come forward on the present occasion to state my views on the subject, which were acquired by theoretical and practical experiments.

All the recent improvements, particularly in breech-loading principles, depend in a great measure on mechanical laws; and I know of one breech-loader, devised and made by a mechanical engineer, which is in my opinion the best, and which will maintain its superiority over all other fire-arms.

Great attention has been given for some time to the study of the different kinds of small arms in use, to the improvements which have been effected lately, to the different projectiles, to the different modes of rifling, and so on, all of which must come into consideration when we speak of military small arms.

I do not think it necessary, and besides it would take up too much time, and perhaps tire the patience of the audience, to go into details regarding muzzle-loading fire-arms; besides, the estimation in which they were held is rapidly declining, and they will soon be one of the things of the past; and I am sure the generation to come will look with the greatest astonishment at a weapon where a stick called a ramrod was necessary to push the charge down into the barrel, when it is so easy to load at the breech. Muzzle-loaders, however, are still used, and every one present is no doubt acquainted with the weapon in use in the English army, I mean the Enfield rifle. Now I have no doubt it will be admitted by all using muzzle-loaders, that loading is a dangerous operation. I, for instance, always feel nervous when pushing the charge down the same road by which it has to come out. The Enfield rifle is an excellent weapon, and at the time of its introduction it was no doubt the best then in existence, but such important improvements have lately been made in fire-arms that it has been decided, I believe to the best of my knowledge, to exchange by degrees the present fire-arm for one more serviceable, and capable of greater execution. To select such an arm it is of importance to consider two things, first, is the new arm to be again a muzzle-loader or a breech-loader.

I am sure every one will agree with me that if we can get a breech-loader that fulfils all the conditions required of a serviceable arm, let it be the one by all means; but to satisfy even the advocates (if there be such) of muzzle-loaders, let us inquire whether there is an arm which is both a perfect muzzle-loader and breech-loader at the same time. If such an arm can be found, decidedly that is the arm which we want, and which will satisfy everybody.

But in the selection of such an arm, it is again important to consider which is the simplest, safest, and cheapest arm of this kind.

The variety of breech-loaders is becoming endless, but all, with the exception of one, fail in the first condition, viz., that there must be no escape of gas, to prevent which almost all require the use of a greased wad, which will never do for a soldier. The reason of this defect is, that in all those breech-loaders, the force of the explosion has a tendency to separate the joint, whilst what is wanted is one in which the force of the explosion *shall close* the joint, and in which the greater the charge, the more effectually shall the joint be closed.

Special ammunition is also very objectionable, for if the special ammunition should be wanting, the arm would be worse than useless. We want a breech-loader which can be loaded with loose powder and ball at the breech if there is no ramrod, or at the muzzle, if there is one, and we choose to do so.

To load with loose powder and ball we must have a solid breech on a solid recoil, and I know only of one which has those desirable pro-

perties. A military arm of this kind must likewise be simple, and must have no delicate parts that require nursing, or it will not do for a soldier. Safety is another great consideration. A breech-loader that cannot be discharged before everything is safe and in its place, and which can be placed without risk in the hands of any raw recruit, is no doubt what is wanted.

Now we come to a very important point, particularly for the country at large, I mean the pockets of the taxpayers. There is no doubt about that, for economy is a very important point.

Now if we can find a breech-loader which is almost as cheap as a muzzle-loader, a great point would be gained; but if we could find a breech-loading principle which could be applied to the existing arms at a nominal cost, that would be best of all. Again, I say there is only one I know of which has all these properties, and I have it here; I am sure it will be interesting to all, for it may be the future arm for warfare, invented and patented by Mr. Mont Storm.

I said before, three points have to be considered, viz.:

First—Simplicity
Second—Safety
Third—Economy.

Let us examine Storm's breech-loading rifle. Is it simple? Most decidedly it is. You have but to open the breech, put the charge in, close it, cap it, and your gun is ready for firing. There are no levers, latches, and all those niceities required to work it, which form an essential part in all other breech-loaders.

In order to give you an idea of its extreme *simplicity*, let us look at its construction. If we take for instance a regular Enfield barrel, cut a piece, say two inches, off the breech end, connect this piece by a hinge with the barrel, so that the breech can be opened and laid on the top of the barrel, fit into this breech-piece a steel tube or valve, which in closing inserts itself into the barrel recessed for the purpose, and which entirely prevents the escape of gas, being in fact the continuation of the barrel, called a valve, gas check, or expanding ring, and of which I shall have occasion to speak more fully presently, and we have a breech-loader of the simplest kind, so simple, in fact, that General Guiod, who made official trials of these guns in France, says in his report to the Emperor:

"That these arms are of a solidity and simplicity, of which no other "arms of this kind can give an idea." And again, in another place he says—

"These breech-loaders fulfil all the conditions required of a perfect "military arm."

It will be observed that the breech A (Plate XX, Figs. 2, 3) is solid, as solid as that of any muzzle-loader; at the back of it is a little recess B, Fig. 3, for the purpose of locking the breech secure in its place. Of this point I shall have to speak when we come to the second head, namely, safety.

But before doing this, I must ask your attention once more to this very ingenious contrivance, called the valve or expanding ring, C, Figs. 2, 3, and it will be seen that no breech-loader can be perfectly gas-tight

WESTLEY RICHARDS

BREECH LOAD

Fig. 4.

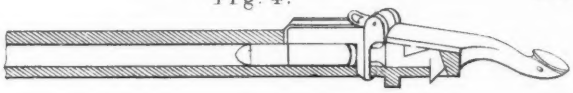


Fig. 5.

Ready to receive charge.

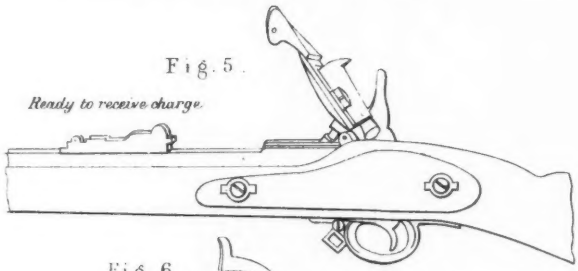
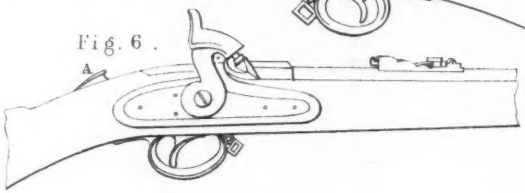


Fig. 6.



MONT STORM'S.

Fig. 1.

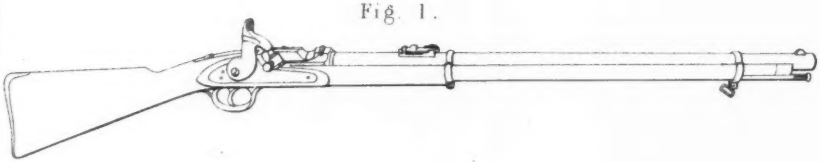


Fig. 2.

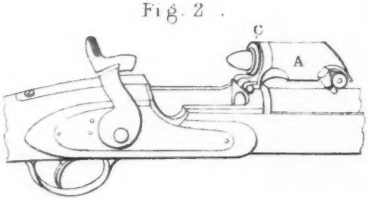
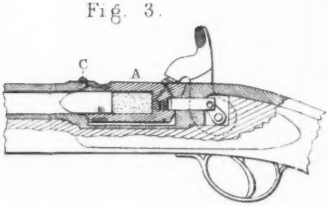


Fig. 3.



LOADING RIFLES

TERRY'S.

Fig. 7.

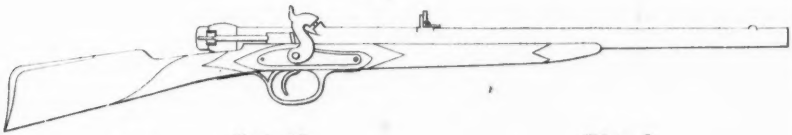


Fig. 10.

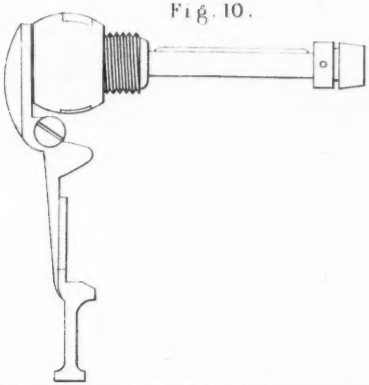


Fig. 8.

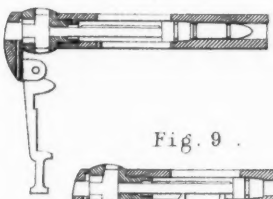
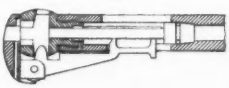


Fig. 9.



GREEN'S.

Fig. 11.

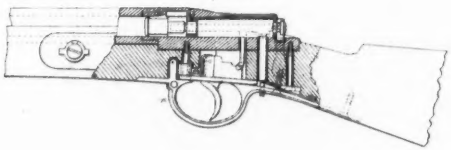


Fig. 12.

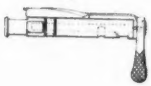
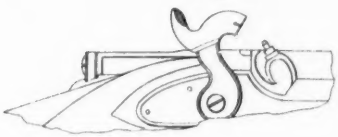


Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.



J.R.Jobbins.

without it. If you look at this little ring you will find that it is at the back tapered down so as to present a surface to the explosive force. Now it is natural that this ring or valve at the discharge will be pressed forward into the barrel, and at the same time expand so as to prevent any escape of gas. So perfect is this contrivance, that at the late meeting at Wimbledon,* such rifles have been fired as many as 400 times in succession, and yet not the slightest escape of gas was perceptible.

It will also be observed as quite natural, that by an increased charge of powder, the ring will, with increased force be pressed against the face of the barrel, in contrast to any other breech-loader in existence. Every one must agree with me that it is the simplest contrivance to get a good and efficient breech-loader.

Speaking of simplicity, I should just like to mention a little circumstance, which was commented upon by many gentlemen, and particularly by some of the Birmingham gun-makers, that is, that the breech fits *so loosely;* and they attribute that no doubt to bad workmanship. Now every gentleman present will know by experience, that all things expand when heated, especially metals. After firing twenty or thirty rounds in rapid succession, breech-loaders that have to fit with mathematical nicety to prevent escape of gas, will stick fast and become useless. Not so with Storm's breech-loader; allowance is made for this circumstance, without depriving the gun of any of the conditions required in a good breech-loader, and therefore the gun can be fired any number of rounds, without any impediment being felt. This is an answer to such futile objections.

The second point, viz., *safety*, is self-evident if we look at the contrivance for locking and securing the breech, B, Fig. 3; it will be seen that the gun cannot possibly be fired without everything being secure in its place, as the hammer could not by any means reach the nipple and explode the cap, and it is altogether impossible to have an accident, and may therefore be given into the hands of raw recruits, as I said before, without the slightest danger.

We now come to the last point, *economy*. Practical men will understand this point better. There is no gun extant, muzzle or breech-loader, that can be turned out so cheap with proper machinery.

Storm's breech-loader can be made cheaper and better than any other gun.

Storm's gun can also be made stronger, and at the same time to look more graceful. Storm's gun can be made to shoot equal to, if not better, than any muzzle-loader. I, for my part, am sure that it will shoot better than any muzzle-loader that can be produced.

Now, if an arm can be made that combines in itself a perfect muzzle-loader, as well as breech-loader in one, that is stronger and more serviceable, and does not require nursing and careful handling; that will shoot equal to, if not better, than any other arm of whatever make or name, that will wear long and stand much use, that is simpler than, and as cheap as any other arm, it is natural that we must call it

* Not the meetings in July, 1864, but in 1863.—Ed.

the most perfect arm of the age. I have said that it is the cheapest arm; I will go a step further, and show that it is an efficient breech-loader, that it is A 1 in every respect; that it is a muzzle-loader at the same time, that it is in fact so good and perfect that no other arm in existence can equal it, can be got that combines two points, simplicity and safety, and can be produced at a small outlay by converting the present Enfield.

I call it economy, as it would save the country millions of money. The present Enfield can be converted or altered into a breech-loader on Mont Storm's principle.

The converted rifle will still be a muzzle-loader, if required; it will be a breech-loader that can be loaded with entire or special ammunition, with the Government ammunition at present in use, or with loose powder and ball at the breech, or at the muzzle of the barrel; in either way it will shoot equally well.

If you consider the terrible execution such an arm is capable of doing, that it can be discharged six or eight times, in case of necessity, in a minute with accuracy; that this arm can be loaded and fired in any position, with entire or breech-loading ammunition, or with loose powder and ball, it must be self-evident that an army with such weapons, is more than three times a match for an army armed with common muzzle-loaders.

Mont Storm's system of breech-loading is applicable to all arms, from the pea rifle, to the largest bore or elephant gun, to the punt gun and field artillery, to 3-pounders and up to 18-pounders.

The jury in the great International Exhibition of 1862 appreciated the merits of these weapons, by awarding it a prize medal, mentioning particularly the merit of its being capable of being applied to the conversion of the Enfield rifle. No one that is at all acquainted with the leading newspapers can have omitted reading in what a spirited manner this subject has been taken up by all and every one, particularly by the *Times*, *Army and Navy Gazette*, *Volunteer Gazette*, &c. Captain Sherard Osborn, an able officer, has shown his appreciation of the principle, by arming the best marksmen belonging to the Anglo-Chinese expedition under his command entirely with this weapon.

A few extracts from some of the leading papers will not be out of place here:—

Times, 13*th July*, 1861.

During yesterday and the day before, Storm's breech-loading rifle was exhibited on the ground (Wimbledon). A description of this *most perfect of all breech-loaders* has already appeared in our columns, and *its immeasurable superiority* over all other weapons of the same kind is so well known now, that further praise is needless.

Times, 15*th July*, 1862.

Mr. Storm's American breech-loader, to which we ventured to direct attention, as being *beyond all doubt* the best breech-loading rifle in the building, has met with the cordial approbation of the jury, who have awarded it a prize-medal, &c.

Times, 31*st July*, 1862.

The American breech-loading rifle is now, since it gained the prize-medal, left out in the Military Court for public examination. The interest which this weapon

is exciting among military visitors, foreigners as well as English, is very great, and seems to be getting greater every day. In the Military Court, the breech apparatus is shown fitted to the Enfield, Whitworth, cavalry, and other rifles, and its *incontestable superiority* over the European inventions of the same kind can be seen the instant the weapons are compared with English, French, or German breech-loaders, &c.

Volunteer Service Gazette, 25th July, 1863.

Just before the conclusion of the meeting a very interesting shooting took place under somewhat novel conditions. The patentees of Mont Storm's rifles had not only a tent on the ground for the display of their invention, but had very wisely given two prizes to be contested for by rifles fitted with their breech—for their invention consists simply in fitting a breech-chamber into any rifle, and thereby converting it from a muzzle-loader into a breech-loader. The principle is an exceedingly simple one; and the patentees have particularly directed their attention to the Enfield rifles, both long and short, so that the Government at a small expense might convert the national weapon at once from a muzzle-loader to a breech-loader. The conditions of the prize were very properly framed, so as to show the great advantage of the breech-loader in quickness of fire, while nothing was sacrificed in precision. Each competitor was accordingly given the use of the butt for two minutes, and he was supplied with a Mont Storm rifle and plenty of ammunition, with which he was at liberty to load and fire as fast as he pleased. There were two prizes to be given to the highest and next highest scores thus obtained. There were upwards of forty competitors, and the first prize was won by Ensign Starkie, of the Queen's (Westminster), who made 34 marks in 11 rounds. The second prize was won by Serjeant Drane, of the London Rifle Brigade, who made 32 marks in 13 rounds. One gentleman fired as many as 15 rounds in the time allotted, while another fired as few as 8. All fired from a sitting or lying down position, and the advantage of loading a breech-loader was seen in a moment, when compared with the intolerably awkward military position of loading a long Enfield muzzle-loader from the knee. The rifleman with the breech-loader need never rise from his lying-down position, and consequently need never expose himself in the least to an enemy's shot—an enormous advantage in skirmishing and outlying or ambuscade work. We are glad to hear that the patentees are organizing a company to bring their invention into general use; and so sure are we that the breech-loader must ere long supersede the muzzle-loader, that we gladly welcome any effort in this direction, and more particularly one that is, as in this case, so closely connected with the national arm. We have watched this rifle with some interest, as it was brought under our notice nearly twelve months ago. We tried it through all the ranges up to 1,000 yards. At that time the inventors had not quite determined on their cartridge, and we used some skin cartridges that were not quite satisfactory. The rifles may now be loaded either with Government ammunition, with an improved skin cartridge, or from the flask, and their shooting at Wimbledon showed the merits of the invention in a very strong light.

No one could have witnessed this contest without contrasting it most favourably with the small-bore shooting of the meeting. The latter, it is true, was carried to the extremest verge of excellence, and bull's-eyes at 1,000 yards were made over and over again: and yet the small-bore has done nothing, literally nothing, in advancing the military defence of the country, and we very much doubt if it ever will advance it. Its very success is, in fact, harking on the leading hounds on a false scent. This Mont Storm contest—almost unobserved, and known but to few who attended the meeting, as it was—on the other hand, is all in the right direction. It showed the military qualities of a rifle in the highest degree—great simplicity, great quickness, great precision; and, man for man, a section of breech-loader riflemen would give an account of a section of small-bore gentlemen before the latter had unpacked their apparatus and got their rifles into working gear.

The following scores were made with

STORM'S BREECH-LOADER.

	Points.	No. of shots.
Ensign Starkie, Queen's (winner)	34	11
J. Drane, London Rifle Brigade	32	13

I will here also subjoin the description of Mont Storm's breech-loading fire-arms in his own words.

Breech-loading arms may be divided into twelve different systems or "species," and there are at least eleven "varieties" of these species. The twelfth species (Mont Storm's "self-sealing chamber system") is of comparatively recent development, and its plan is adapted so as to be universally applicable to every style and class both of military and sporting arms, or the ready conversion of present muzzle-loading arms into breech-loaders. Some of its many points of merit may be enumerated as follows :—

It has a chamber, but no lever, either lateral, vertical, or of any other description, to catch in the accoutrements, dress, or bridle-rein.

It is confined to no special ammunition.

The charge may be varied, but the arm cannot be overloaded.

The explosion takes place within a solid chamber. The recoil is upon a solid breech.

The connection between the stock and barrel is strong, graceful, and "fixed:" thus it is adapted for the use of the bayonet for infantry.

The opening and closing of the chamber is effected with unprecedented ease and rapidity by means of the mere finger and thumb, even when the weapon and the soldier are lying upon the ground, and, in the case of cavalry in action, the left hand remains entirely free to govern the reins. It is a perfect muzzle-loader. The force of the explosion—irrespective of special ammunition—closes the joint, in contrast to its effect in other breech-loading arms; thus there is no escape of gas.

It cannot stick fast or clog by rust or powder dirt.

There is no sliding or abrasion of one surface upon another in opening and closing the breech, so there is no wear by friction.

In the insertion of the cartridge, the ball constitutes the handle or ramrod—an important feature.

It cannot be fired accidentally or purposely till the chamber is locked in place; and the locking device is solid, "self-acting," and infallible in its operation.

It is extremely simple, involves no delicate parts, and cannot easily get out of order.

There are no specialties of lock, stock, barrel, or mountings: thus there are no mysteries in its repair: it is of economical construction, and an approved species of "self-acting primer" may be applied to it.

These arms may be thoroughly and quickly cleaned without the application of water.

Though these arms are only now about to be brought before the public in this country, they have received greater approbation at numerous public trials before Governmental and military authorities in America than any arm hitherto known.

WM. MONT STORM, N.Y.

3, ROOD LANE,
January 1, 1863.

Mr. PHELPS: This is the valve (opening). The explosion taking place in the chamber drives everything before it, and so doing, the lips of the valve are taken against the lips of the barrel preventing the escape there would otherwise be of the gas. It is a solid breech,—it is merely the end of the barrel cut off or another substituted for it. It is solid, just the same as if it was a muzzle-loader, and the recoil is on the solid base of the gun.

The CHAIRMAN: How is it closed at the joint where the hinge is?

Mr. PHELPS: The breech-piece is merely attached by the hinge to the barrel. The gas is prevented escaping by the valve fitting into the end of the barrel.

The CHAIRMAN: Is there a double valve?
Mr. PHELPS: There is only one valve.
The CHAIRMAN: Is there a straight vent into the chamber?
Mr. PHELPS: An angular one.
The CHAIRMAN: There is objection to that angle.

General BOILEAU, R.E., F.R.S.: I wish to make a few remarks on the principle of this rifle. If you will allow me, I will take it into my hands and explain my remarks. It is, Mr. Chairman, a matter of paramount importance that we should consider all the circumstances connected with every invention which is brought forward in this theatre, because I believe that Government look greatly to the discussions which take place here, for opinions which they probably would not receive otherwise; and on that ground I think we ought not to allow the points which have been brought before us this evening to pass without the expression of some opinion as to the quality of gun which is submitted, and also as to its comparison with other breech-loading guns which have been brought under Government notice, and some of which are introduced into the army. Without any wish to refer personally to the inventor of this very beautiful and highly-finished piece, I may say a few words on the principle involved in its construction, because it is on that only I wish to speak. To commence with the principle: I may say that it is acknowledged that curvilinear motion, which is to be resolved into rectilinear motion, is not the principle which you should have where the object is to bring two surfaces into contact the one with the other. It is desirable that the motion should be in a straight line, and therefore I think that all hinge breeches of this description, which turn over for the purpose of loading, and which are obliged to be turned back for the purpose of closing the two surfaces to be brought into contact, is not a correct principle. I have a great objection to the manner in which this gun is loaded. The gentleman who read the paper says he loads by the muzzle always with great fear. I have fired many thousand rounds from muzzle-loading rifles, and I do so with the most perfect certainty that there is no danger at all in the operation. In fact, I feel that I can load a gun from the muzzle with very much more security than I can load this gun from the breech; because in putting the cartridge in, I counter-march the breech before I begin, and then put the powder and bullet in in the reverse order in which they are to go out. That is, I place the bullet towards my own body, instead of towards the proper object to be fired at. Then as to the method in which the breech is closed, I don't think there is a perfect contact between the two surfaces, because from the explosion of the powder, if there is a valve which is supposed to close the breech, it must to a certain extent jamb, and in lifting up the breech in this way, there would be a friction upon the lower part and a scraping upon the upper part, which would in a short time, according to my apprehension, bring about a leakage of gas. Then in respect to the power which this gun is said to possess, of being loaded from any position, supposing it is required to load it with loose powder by the breech, how is this to be done when in such a position as this—kneeling or lying down? It can only be loaded with special cartridges from the breech, or Government, or other similar cartridges from the muzzle. I will now notice several forms of breech-loaders on the principle of direct action, all of which have their advocates, and are deserving of a separate description. Westley Richards's breech-loader (exhibiting one), see Plate XX, figs. 4, 5, 6, has a lift piece which carries a piston; the piston has at its fore end a gun metal or a copper plug, and at the rear end has a sloping shoulder, working against a stud. The cartridge is introduced bullet foremost, as I believe it is the only way it would be introduced by a soldier. The breech-piece is turned down, the piston works against the stud at the end of the chamber, and when the breech-piece is brought down home, the metal plug is pressed firmly into the barrel, and the gun is thus made perfectly gas-tight. Many thousand rounds have been fired out of Westley Richards's breech-loaders, and they have remained to the last as efficient as when first used. I believe a number of them have been introduced into the army, and I am informed they have given great satisfaction.

Another form of breech-loader is that of Calisher and Terry, figs. 7, 8, 9, 10. This (exhibiting the rifle) has also a direct acting piston. There is a side lever which moves on a hinge. This I consider to be its great objection. The side lever is

detached in this way (moving it). The piston is turned round, withdrawn, and the cartridge is put in, bullet foremost. The piston is then returned, the lever carried back, shut, and the piece is ready to fire. This, as far as the principle of action goes, has this objection, that when the plug is forced home, there is no play; it comes in contact with the solid end of the barrel, and, therefore, when the fore portion of the piston wears, the gas escapes, and the side lever is liable to be blown out. That I consider to be an objection to this principle, which has possibly acted to some extent in not securing for it that favour which the other portions of the invention entitle it to.

The last design I would bring to your notice is a form of breech-loader with which I have myself had something to do, and therefore it is a great pet of my own. It is the invention of Mr. Green (figs. 11—16), a gentleman of great mechanical ability, with a fair amount of practical experience, and the result appears to me to do great credit to his inventive talent and mechanical skill. It consists of a piston also, at the end of which a lever is fixed. The lever is raised in this way (working it), and the breech-piece withdrawn. The cartridge is put in bullet foremost, the breech-piece is pushed forward, the lever put down, and the piece is ready for action. Now there is one part of this design which secures the same ends that Mont Storm does, and that is a great advantage in both of these designs, namely, that until you have completed your arrangements for closing the breech, you cannot fire the piece. At the under surface of the piston there is a hole which has to be brought vertically over a pin before the gun can be fired. If you leave the lever in any position where the hole is not over the pin, you cannot fire the piece; but when you put the lever quite down, and the hole is brought over the pin, the piece may then be fired, so that it is perfectly secure. Then this rifle has an advantage which I do not see in other breech-loading small arms, namely, that you can detach your piston altogether, and throw it away, if you like, which under some circumstances is a great advantage. I dare say many of my hearers remember when the gunmakers of London received an order from the Government to take all the locks off the muskets that they had in store, fearful that they would be made use of for improper purposes during riots. So in India, if we had had breech-loading guns from which we could have removed the pistons, we should have taken away a very great amount of the advantage which the mutineers derived from the possession of Government small arms. This breech-loader of Mr. Green's has that advantage. By pushing the trigger forward you can take the breech-piece out, and destroy or throw it away, when, if your enemy gets possession of the rifle, it is useless to him as a fire-arm. These are points in which I consider Mr. Green's breech-loader has great advantages. Such is the description of Mr. Green's patent breech-loader; and without in any way wishing to speak of individuals, I think the advantages are decidedly in favour of this design. Government have, I am told, viewed it favourably, and Mr. Green is fitting his breech-loading apparatus to different descriptions of Government small arms for trial. I have seen one of these guns which fired 1,000 rounds, 700 from the breech, and 300 from the muzzle, almost without a perception of the effect of smoke in the breech chamber. I have myself fired with them when they were in a more imperfect state than they are now, many rounds from the rest, from the shoulder, and from the knee, and I have found their action easy and certain, and the escape of gas imperceptible. There is another point which I consider to be a very great improvement on all other methods of closing the chambers that I have seen. The fore end of the piston consists of a disc fixed on an axis, working on the piston against another disc fixed to the end of the piston or plug, and interposed between the two is a wad of vulcanised india-rubber. There is a slight slot motion for the fore disc axis, so that when the powder explodes it presses backwards upon the vulcanised india-rubber wad between the two discs, and most perfectly and completely prevents the escape of any gas. When the gun is used as a muzzle-loader, a wad of vulcanised india-rubber, rather tight for the barrel, is first passed down, and with that wad several hundred rounds have been fired from the muzzle without more than a discoloration of the surface of the wad. I think if any breech-loading piece is to be generally introduced into our army, and I am not one of those who think breech-loaders will altogether supersede muzzle-loaders, at all events, for some time yet to come, Mr. Green's breech-loader, manufactured by Reilly, ought to command the attention

of Government, as it will, I firmly believe, have the approbation of all men interested in improving the weapons which are placed in our soldiers' hands.

Captain RADCLIFFE, R.N.: I wish to observe that I do not think Mont Storm can claim any novelty in his gun; for four or five years ago, I brought forward the same system. I took it to Mr. Wilkinson, and he told me, "It is a very good thing, but you cannot do anything with it, because the bolt is Leech's Patent." How Mr. Mont Storm has got over that I do not know. I thought it was then of no use my doing anything with it.

The CHAIRMAN: When you say the bolt, you allude to the hinge?

Captain RADCLIFFE: The bolt which secures it in the breech. This other part was invented by Captain Palliser, of the 18th Hussars. I took no more notice of it at the time, and should not have done, till some time since, I saw Mont Storm's gun, and looking at it, I saw it was exactly the same thing except in the valve, which I do not attach so much importance to, because, if you look at this (exhibiting a rifle), you will see, by having a soft metal ring which would expand with the heat when fired, it would stop all escape of gas. If you look at it, you will see it is exactly the same principle as Mont Storm's.

The CHAIRMAN: Do you invert your cartridge?

Captain RADCLIFFE: No. I am not going to bring this subject forward, as I did not anticipate anything would arise. This rifle was made four or five years ago. If you will look at it, you will see it is as similar as possible to Mont Storm's, except that my bolt is at the side. It is the same principle. One great objection is, that if the nipple were worn, the hole would be very large, and it would throw the hammer back, and then the thing would get out of order. Another objection is, that in loading, the powder gets into the bed under the breech, and when you put it down you cannot shut it. This might be obviated by cutting a piece out of the bed to allow the powder to force through. I merely mention it to show that Mr. Mont Storm cannot claim the invention, for I have had this five years.

Mr. BETHEL BURTON: The gentleman who has favoured the meeting by reading the paper has endeavoured to impress upon us the superiority of his system. I have the pleasure of laying before this meeting a breech-loading gun of my invention, and am content to submit it to the judgment of the many gentlemen of known ability I see present, that they may form their own conclusions, first giving an explanation of the arm before them. It is made from an Enfield rifle, adapting the materials at present used for its construction, so that rifles already in use can be altered, according to this system, at a trifling expense. The great difficulty attending breech-loaders is, that they are found, after a little use, to allow an escape of gas at the joints, and every conceivable plan has been resorted to to prevent this evil. It is pretty generally admitted, that if the joint can be effectually closed, and a strong serviceable gun produced, the breech-loader would supersede the present muzzle-loader. I hold in my hand a gun in which no mathematically-fitting joint is required in order to prevent an escape of gas, and, consequently, there is no joint to wear out. The gun is strong and very simple. There is only one screw used for the purpose of keeping the breech-piece together, and it may be withdrawn for the purpose of cleaning, leaving the barrel open from end to end. The means employed to prevent the escape of gas consists of a copper case or cartridge, made without seam, containing the powder and bullet, and in the base, the fulminate, which is ignited by a blow. This cartridge is the most perfect of its kind. It is perfectly air and water-tight, so that the rifle may be fired during heavy rain, or after the cartridge has been immersed in water for hours. It cannot be ignited save by the means now employed, or similar mechanical means; it cannot be ignited by a spark or a flash from the fire of a gun, as is the case with the paper cartridges now used. It is also cheaper than the paper cartridge at first cost, and can be refilled as often as desired. Under the present system, in time of war when extensive guard and picket duty is necessary, the soldiers coming off duty are obliged to discharge their guns, involving the loss of the cartridges, besides the labour of cleaning the guns. With this cartridge, that is entirely obviated, as it may be withdrawn at pleasure by opening the breech, the gun of itself ejecting the cartridge, which is saved for future use. I calculate that this saving alone will pay for the extra cost of the new arm. There is no nipple to clog up or split, and no

cap to put on, which operation is rather difficult to perform in cold weather or on horseback, or in the hurry and excitement of battle. This advantage will enable the soldier to defend himself against superior numbers, as the rifle can be fired twelve times a minute, as readily as the muzzle-loader can fire three shots, and it is not at all affected by rapid firing. In case of necessity, it can be loaded by the muzzle with the ordinary cartridge, or with loose powder and cap, quite as effectually as the Enfield or other weapons. The breech works without fouling, and it may be fired 1,000 rounds or more, as long as the barrel remains clean; and, if the barrel could be kept clean, the breech would fire 10,000 rounds without requiring cleaning. In conclusion, I will say that if Mr. Mont Storm considers the challenge he has thrown out as a *bonâ fide* challenge, I am ready to accept it, and to enter the lists at any stated period, competing with him for rapidity of firing, accuracy, penetration, and freedom from gas escape, and also to shoot the greatest number of rounds. I am anxious to try my rifle against any gun, either in England or America, and will leave it to any disinterested military man to decide which is the better gun for military purposes, such referee to be named by Her Majesty's Secretary for War.

Mr. BYRNE: I am acquainted with Mr. Mont Storm, and I should be very sorry to say anything against his gun in his absence. As to the ammunition Mr. Burton has spoken of, they can make these cartridges in the United States for less then a cent a piece,—ball, powder, fulminate, and all at the rate of 300 a minute. That cartridge is made cheaper than the paper cartridges made by Government here. The cartridge can be put in water for twelve hours; you can take it out of the water and it is immediately ready for use; you can throw them against a wall, you may sit upon them, you may throw a bomb shell among a house full of them and they will never explode. They never explode without the proper application of the hammer. Indeed, I may say all breech-loading guns are practically useless without that particular sort of cartridge. That is the cartridge now used in the terrible war now waging in the United States.

The CHAIRMAN: That cartridge would not do for Mont Storm's rifle.

Mr. BYRNE: I think this is well worthy the attention of military men: I have tried all the various breech-loading guns made; in fact, I had folly enough to buy a good many of them, and at last I got one of these guns of Mr. Burton's. I fired 10,000 rounds out of it, and it is now as perfect and as clean as when I began. By making the bullet of lead having a composition of certain other metals, it never leads the barrel; that I think is a great point. There is no residue remaining, and if any one will take one of these guns to a United States officer, he is bound to have that particular sort of shot.

Mr. BRAENDLIN: It would take me as long to explain Storm's breech-loader as to explain the other guns. The other breech guns exhibited here this evening look something like gas-pipes, they are not natural looking guns, none of them can be fired with loose powder. If I am out in the colonies and have none of that particular ammunition, if I cannot make up a cartridge, the gun cannot be loaded and is useless. I can load Mont Storm's breech-loader in any way I please. If you were to take Westley Richards or any other breech-loader, and load it from the muzzle, driving the ramrod down you would destroy the gun. You would destroy Mr. Green's in that way.

The CHAIRMAN: Mr. Green's may be loaded from the muzzle.

Mr. BURTON: So does mine.

Mr. BRAENDLIN: You can fire only one or two rounds.

General BOILEAU: I have fired seventy or eighty rounds in succession. If any gentleman doubts that Mr. Green's gun can be loaded from the muzzle, I shall be happy to fire 100 rounds in his presence any day.

Mr. BRAENDLIN: With Mont Storm's gun I can use the Government ammunition and powder from the flask. Ten thousand rounds might be fired from it, which is more than can be done with any other breech-loader. An observation has been made about the abrasion of the surfaces. If you look carefully at Mont Storm's gun, you will find there is not the slightest friction in any portion of it. The valve re-inserts itself in the barrel, fits perfectly, and the breech is perfectly placed. It is the only rifle where everything is perfectly loose and can be worked without any friction.

I have fired Westley Richards' breech-loader, and have seen attempts made to fire it with loose powder, when on one occasion it burnt a gentleman's eye away. Had I known these other guns were to be introduced, I would have brought several specimens of Mont Storm's gun with me and would have explained them. This gun can be loaded from a powder flask when the soldier is lying down.

General BOILEAU: But you do not give a soldier a powder flask.

Mr. BRAENDLIN: In case of necessity.

General BOILEAU: Never, now.

Mr. BRAENDLIN: If I can load either way, it is certainly better than if I can only load one way: you will admit this. I have shown that I can load from the muzzle, I can load with loose powder, and I can fire with special ammunition. I do not think there is one breech-loader that would do what Mont Storm's did last year at the Wimbledon meeting.

General BOILEAU: I dare say there will be a competition this year.

Mr. BRAENDLIN: Yes, I dare say there will, because Mont Storm will give a very great prize and will see whose breech-loader is the best. This point will be settled. I think all breech-loaders that require special ammunition, or ammunition with fulminate in them are worthless.

Mr. BYRNE: Will you give us the reason why they are worthless?

Mr. BRAENDLIN: Because they are dangerous.

Mr. BYRNE: That is no reason.

Mr. BRAENDLIN: That is a very good reason.

Mr. BYRNE: Boiling water is dangerous.

The CHAIRMAN: We are very much obliged to you for bringing this subject forward, but I think you are a little under misapprehension; you know in all these discussions our object is to find fault, and if we can find fault with a thing best by bringing another into contrast, that is the right way. We are here as censors, and our business is to find the weak points, and it is for the inventor to strengthen those points if he can. I do not think there can be anything really progressive or satisfactory, unless that mode is adopted. There is no doubt Mont Storm's gun has considerable merit over many others; but I think as General Boileau has shown, that the language of depreciation used was rather strong, inasmuch as the assertions were not supported by proofs, but we are much obliged to you for bringing this subject forward, and I am sure these discussions cannot but tend to good. You have heard the comment made upon your rifle, and it will enable you to correct some of its defects.

DESCRIPTION OF BREECH-LOADERS ON PLATE XX.

MONT-STORM'S.

Fig. 1, side elevation of Enfield rifle fitted with Mont Storm's breech-loading chamber.
Fig. 2, breech raised, showing cartridge in chamber.
Fig. 3, side view, partly in section, showing position of breech at the moment of firing.

WESTLEY RICHARDS'.

Fig. 4 represents cartridge inserted and breech closed.
Fig. 5 shows breech open to receive cartridge.
Fig. 6, appearance of rifle, with breech closed.

TERRY'S.

Fig. 7, side elevation of musket, with breech apparatus.
Fig. 8, breech apparatus, with cartridge inserted in barrel
Fig. 9, breech apparatus detached, closed up to breech.
Fig. 10, enlarged view of breech apparatus.

GREEN'S.

Fig. 11, side view partly in section, showing breech apparatus.
Fig. 12, piston or bolt, and the cover of the breech chamber.
Fig. 13, transverse section of the cover of the breech chamber and piston, or bolt.
Fig. 14, end view of ditto.
Fig. 15, breech-plug loose in breech plate, which partly turns round in plate.
Fig. 16, side view, with breech closed, and ready for capping.

LECTURE.

Friday, April 29th, 1864.

LIEUTENANT-GENERAL P. SPENCER STANHOPE, in the Chair.

THE PROGRESSIVE AND POSSIBLE DEVELOPMENT OF INFANTRY DRILL AND MANŒUVRES.

By Major TALBOT HARVEY, 1st Middlesex Eng. Vols., formerly Austrian Service and Suffolk Mil. Art.

IT may be said that the claims which modern times can justly lay to persons devoted to the cultivation of every branch of human knowledge, are in direct proportion to the degrees of perfection to which the sciences themselves have respectively attained; the most striking proofs of which assertion are to be found among those who now pursue the military career.

The only way in which one can account for the want of attention or improvement that drill and manœuvre has met with is, "that it might have been thought of by any one," or perhaps "that it is one of those things taken on trust, because it is apparently too plain to require a moment's consideration." Tactics being the order or disposition of an army, and evolution the movement which conducts to that order, it is quite clear that however great a tactitian a general may be, the smart carrying out of the new order is dependent on the evolutions or manœuvres of a battalion. Although the manœuvring of a battalion has not been looked upon as a science, still it must be allowed that it is at the root of all field movements.

The fate of a battle, particularly in modern warfare, is often dependent on a brigade or battalion being able to grasp, without loss of time, any advantage offered by the enemy. For that reason it is necessary that manœuvres should comprise every movement that a battalion may be required to perform under the most adverse circumstances.

The subject being one that, to go into properly, requires more time than is at my disposal, I propose touching on the progressive development of infantry only so far as is necessary to strengthen what it will be my endeavour to prove, namely, "that a further development is

possible and necessary." The changes that have taken place in the drill and evolutions of companies and battalions, since the first introduction of standing armies, have been gradual, and all tending to simplify and accelerate their movements.

Beginning with the position of officers, we find that—

1st. They were posted by seniority, irrespective of companies, in front of the line.

2ndly. They were placed in front of their companies.

And, lastly, changed in most armies to almost the same position they hold in our service.

The strength of companies and battalions have, on the other hand, undergone great changes, a company having ranged in some armies as high as 300 men, the cause for reduction being the difficulty experienced of manœuvring a battalion with rapidity, when composed of such unwieldy units. Italy may be said to have taken the lead in that respect, as her rifle battalions consist of six companies of 50 men each. Colonel Dalrymple, in 1759, while alluding to the strength of a regiment, which was then the same as now, only that they stood in three ranks, says: "The strength of our present establishment is certainly too great. Three hundred files, were it possible to make them march in rugged ground without confusion, must yet be a very unwieldy body. Every body of troops which is not light and active is equally encumbered by numbers as by any other impediment, and subject to fall into disorder in action."

Whatever alterations may take place in drill and manœuvres it is essential the units of battalions and the units of brigades be reduced; the companies to 50 or 60 men, and the battalion to 6 or 8 companies. The unwieldiness of a regiment in line has been, to a great extent, acknowledged, as well as the difficulty at times experienced of a commanding officer's voice being heard.

The reasons generally given for keeping up the establishment of a regiment at its present strength are purely financial:

1st. That the expenses of working a battalion 1,000 strong are the same as 600.

2nd. That the expenses of keeping up bands, messes, etc., would be too great for a smaller body of officers and men.

Might not those administrative difficulties be overcome without affecting the efficiency of a battalion in the field?

Without going back to that period when companies were formed eight deep, the alterations that have taken place prove that more is daily expected from the soldier, and that the period is not far distant when his training will have to undergo that radical change which is necessary to enable the evolutions of battalions to keep up with the destructive powers of modern weapons which the ingenuity of man is daily inventing and improving.

We find that from two ranks the more careful training of a soldier has enabled us to obtain greater results than from the old formation of four or three; no doubt owing, also, to the superior arm we have placed in his hands.

In looking over some old and valuable works belonging to the

library of this Institution, and also that of the British Museum, I have been very much struck with the fact that although important changes and alterations have been suggested from time to time by officers of great experience, they have been allowed to lie dormant for years, and that nothing but bitter experience in the next war has been able to produce the changes suggested and required. However, it is but justice to add, that owing to an enlightened spirit, which is gradually finding its way into the administration of all armies, improvements, in spite of unnecessary routine, are daily taking place, and that the army is more and more, particularly in this country, acquiring the right of being called a profession that demands study and application, and not a pastime. To quote Captain Mountsteven, who, in 1842, aimed almost at the same thing as myself, "celerity and security are the great points to be attended to in manœuvring." No manœuvre should ever be permitted on parade which cannot be used in action; but also that our system should be so complete as to guard regiments against the risk of being forced into movements in presence of an enemy, which they are not in the habit of constantly practising elsewhere.

Indeed, the whole subject may very fairly be brought within the two following propositions:—

First. Does the existing system provide a manœuvre suited to every situation in which a battalion may require to be placed in action, or into which it is likely it may be forced by the enemy, to the exclusion of all others; and are the movements so provided, performed in the quickest way possible, as well as in that in which there is the least chance of mistake?

Secondly. If this be not the case, how can a system be provided that will remedy those defects?

The answer I would venture to give is:

First. *By studying the individuality of the soldier.*

Secondly. *By so simplifying all movements as to ensure their rapid execution without intermediate words of command;* and,

Lastly. *By wording all commands in such a manner as to clearly indicate what the next movement will be.*

First. *Studying the individuality of the soldier.*

The introduction of arms of precision has, to a certain extent, cut at the root of the old system, and turned the attention of all countries, especially of our own, to the necessity of at least instructing the soldier in the use of his rifle. That important end having been attained, the next question is, how far, with due regard to rapidity, the present drill can be so simplified as to enable the soldier to understand the movement in view, and act without the numerous aids, which at a critical moment may fail.

If a soldier is conscious that the smartness of a movement is dependant on his own individual exertion, it will give him greater interest in his work, and will be an incentive to acquire his duties. But if he is only looked upon as a mere machine, it will be impossible to give a battalion that elasticity which is so essential to further development. It is the idea, that from a man in the ranks nothing more than obedience is required, that makes him careless, and depend on the

assistance of his superiors. If, instead of useless guard-mounting, as is too much the case in our large garrisons, the soldier's time was taken up in his mental and bodily training, it would add to his health, efficiency and happiness, and also induce a superior class of men to join the army. It is only by raising the soldier in his own estimation and that of his fellow-citizens, that you will be able to improve the morale of the service, and abolish that demoralising system of recruiting at present in force.

The Marquis of Santa Cruz says, "One should accustom soldiers to throw up earth, to make fascines, and to place them properly, to plant picquets, to know how to make use of gabions to entrench with, making the ditch, parapet, and banquette, where the engineers shall trace them, or the parapet and banquette only, taking the earth from within, as is done in the trenches made for the attack of a place; for when there is occasion really to perform these works, the soldiers who are not well practsied in them, will find themselves quite at a loss, and will do them both slowly and imperfectly, particularly if in presence of an enemy."

By the mental training of a soldier, I may, perhaps, mean more than most people will allow to be necessary, still experience has taught, that intelligence will often cope successfully with courage and numbers. The strides that science is daily making, and the loss of life and treasure that is entailed by modern warfare, demand that the soldier should receive the highest training that can be given him; so that the country in return for the great sacrifice that war entails, should be enabled to secure the greatest results. His mental training ought to consist of a knowledge of reading, writing, arithmetic, first outlines of geography and military history; theoretical, as well as practical instruction in company, battalion, and light infantry drill, musketry, and first outlines of field fortification; a necessary knowledge of cooking, and making himself at home under all circumstances. In his bodily training, I would include gymnastics, sword and bayonet exercise and swimming.

It is by thus studying the individuality of the soldier, that you will give him that confidence in himself, which will make him try, and if possible overcome, all obstacles that may present themselves. Courage and science combined, going a long way towards ensuring victory.

Secondly. *By so simplifying all movements as to ensure their rapid execution, without intermediate words of command.*

Colonel Dalrymple, more than a century back said, "The art of the manœuvre of troops consists only in distributing motion equally to every part, so far as can be, to enable the whole to form or change their positions in the most expeditious and best method to answer the purposes required of a battalion, brigade, or line of infantry. It becomes necessary to introduce a plain and easy method how the front may be expeditiously changed to oppose any sudden and unforseen attack on either flank." The drill book of 1770 says, "That all manœuvres be executed by one single order, and that they be as simple as possible." And lastly, Captain Mountsteven adds, "I consider the true system of acting in the field to be, not only to perform

those manœuvres which are absolutely necessary in the quickest and plainest way possible, but also never to make any alteration in our formation in presence of an enemy, unless we cannot avoid it without manifest disadvantage. I know not in what way a more successful effort can be made to circumscribe its limits, than by altering our manœuvres until they become as simple, practicable and complete, as they are capable of being made. The three quotations I have made will be sufficient to prove, that the principle of simplifying and accelerating all movements, has been acknowledged for the last century and a half, and is still only partially carried out.

All movements, whether company, battalion, or brigade, may be divided into *actual formations*, and *intermediate movements*. An actual formation, being the result of intermediate movements, and a position in which a body of men would receive or attack an enemy. Actual formations may again be divided into—

Formations in line,
" " column,
" " echellon,
" " square, and
" " extended order.

All other sections in the drill-book must necessarily come under the head of intermediate movements; that is movements necessary to enable a battalion to change from one actual to another more suited actual formation.

It is on the simplicity of these intermediate movements, that the successful accomplishment of an actual formation depends.

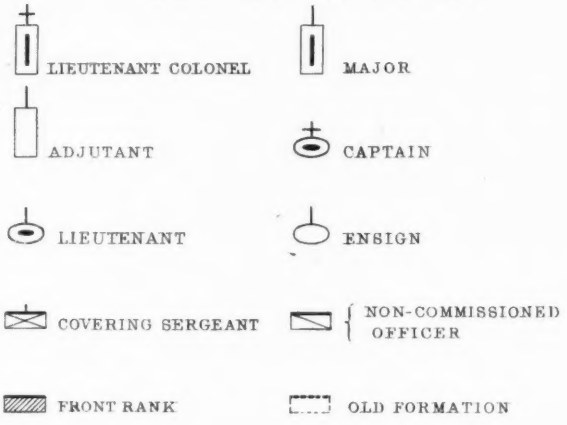
Assimilating the movements and words of command of a company with those of a battalion, will also tend to make the acquirement of drill easier, and less liable to confusion.

Captain Mountsteven says—"To obtain rapidity, a corps must always "move by the shortest and most direct way, from the formation it "may happen to be in, without any regard to its being what is termed "clubbed, or as to which rank is in front." In other words, on the directness of intermediate movements, from one point of formation to another, will depend rapidity of execution. It need hardly be added, that if the present system deprives the commander of a battalion of that liberty of action which is so essential, how much more so must it not hamper a brigadier, and so on.

As it would be impossible in a lecture to go into the minutiæ of all the changes proposed, I will confine myself by stating the reasons why some movements may be entirely omitted, and how others may be simplified. To avoid mistakes and enable a commander to alter the order of companies, I would suggest that off parade they should be lettered as *A, or Captain Smith's Company;* and that the telling off of a battalion be resorted to as often as needed, either from the halt or on the march.

In section 43 of Squad Drill, and section 17 of Company Drill, I would introduce the following alteration:—"That a squad or company can front-form company to either side of the leading file, according to Fig. 1, Plate XXI, without regard as to whether its right or left in

KEY TO PLATES.



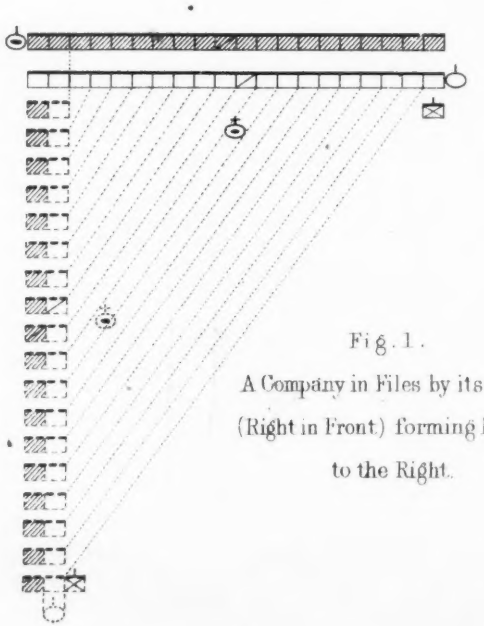
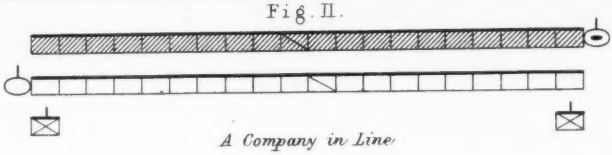


Fig. 1.

A Company in Files by its Left (Right in Front) forming Front to the Right.

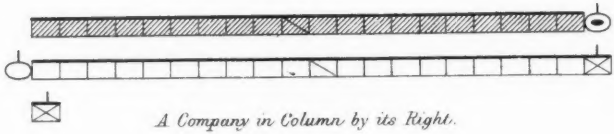
J.R.Jobbins

Fig. II.



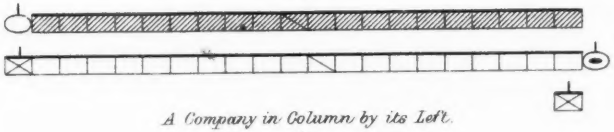
A Company in Line

Fig. III.



A Company in Column by its Right.

Fig. IV.



A Company in Column by its Left.

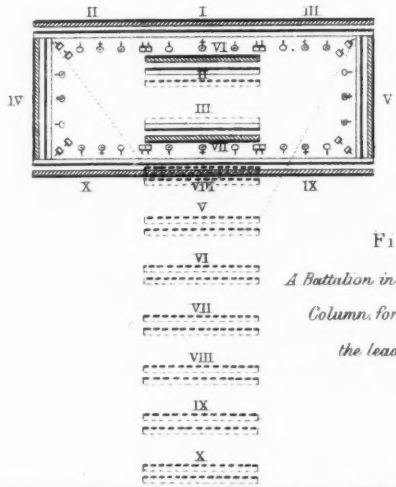


Fig. VI.

A Battalion in Quarter Distance Column, forming Square on the leading Company.

front, or, according to the new system proposed, by its right or left." The word of command would be *right, or left, front-form company.*

In section 1 of Company Drill, I would suggest the following alteration :—" That on the caution '*as a company in line,*' (see Plate XXII, Fig. " II) the captain should place himself in rear of the centre of his com- " pany. The lieutenant on the right of the front rank, the ensign on " the left of the rear rank; 1st covering sergeant in rear of the right " file; 2nd covering sergeant in rear of the left file; and the 3rd ser- " geant in rear of the left front rank man of the right sub-division; " the 4th in front of the right rear-rank man of the left sub-divi- " sion."

The reasons for placing the captain in rear of his company are—

1st. That it enables him to give his men that superintendence which is essential and at present impossible, and

2ndly. That it gives him liberty of moving about and attending in person to any derangement or mistake that might occur.

By altering the position of the ensign and reducing the number of the supernumerary rank, it will enable a commander to invert the order of ranks as it suits him best.

In section 2, *as a company in column, right or left in front*, I shall include *countermarching* by *ranks, files*, and *sub-divisions.*

Unfortunately, an idea has been taken up that it is absolutely necessary always to keep one and the same rank in front; to accomplish which end, many round about, intricate and slow movements were introduced, all of them totally useless for any other purpose. In fact it may be said, that owing to it, our movements labour under the great disadvantage of being nearly doubled in number and more than doubled in complication. The position of a rank in a company, or a company in a column ought to be no longer considered. In fact it should make no difference to the denomination or action of a battalion, which of the two ranks happen to be in front.

Captain Mountsteven says, " The principle change now proposed in " a long tried system may be thought to be too violent; but it must " be recollected that our still long and complicated set of manœuvres " cannot be materially shortened and simplified without it: for every- " thing has been done already to that end, which can be done whilst " we retain our present plan, with regard to the use of the ranks. It " must also be remembered that no new forms for meeting an enemy " are contended for, but only safer and more expeditious methods of " executing those which already exist."

The improved method of sizing a company, as at present in force, by making the rear rank the same height as the front, and the faulty system still adhered to in some countries, of placing the most efficient men in the front rank, having been done away with, obviates the necessity of trying as much as possible to keep a certain rank in front, a rule which must necessarily hamper a commanding officer, and deprive him of that liberty of action which is absolutely necessary to enable him to show a front under all circumstances.

There certainly is a sanction given in the drill-book for inverting the order of companies, but still why, instead of being sanctioned,

should it not form part and parcel of the system? The sanction implies that a necessity might arise for putting into force what is only partially recognised as necessary. A system should be laid down and no deviation allowed.

For the reasons given, I propose the following alterations:—

First. That instead of "as a company in column right or left in front," it should be, "*as a company by its right or left*" (Fig. 3). On the caution *by its right*, the officers and supernumeraries would fall in as a company in line, excepting the right covering sergeant, who places himself in rear of the lieutenant. On the caution, "*by its left*," (Fig. 4) the lieutenant will place himself on the right of the rear rank, and the ensign on the left of the front rank, left covering sergeant in rear of the ensign, the captain and remaining covering-sergeant as in line. To save repetition, it may be stated once for all, that the captain always retains his position in rear of the company.

The second alteration I would suggest is, that countermarching by ranks, files, and sub-divisions be omitted as a roundabout way of accomplishing what may be effected in a speedier and simpler manner, by "*facing about* and *denoting the pivot*." The result will be this: that if it was desirable to change the front of a company or column permanently to the rear, and still retain the same alignement, all that is required, if they have been marching by the right, is "*right-about turn*." On the caution "*turn*," the captain will pass through the centre to the new rear (by which an advantage will be gained of keeping up correctly the telling-off of pivot men of sub-divisions), the covering-sergeants will pass round the outward flanks of their companies. On the caution, "*by your left*," the lieutenant will step up to the new front rank, and the ensign will fall back to the new rear rank. But if it is desirable to change the alignement on the *caution* "*by your right*," the lieutenant and ensign will retain their former positions.

Formation of Column from Line.—As the formation of column from line and deployments often take place under fire, with little time to do them in, it becomes doubly necessary that the intermediate movements should not be dependant on endless secondary commands, as in action, they might easily not be heard, and in consequence produce confusion. For that reason I propose, 1st,—that to complete either formation, intermediate words of command should be abolished; and, 2ndly,—that the intermediate movement should be in files, or close columns of sub-divisions, instead of fours. Fours may do very well for route marching or parade purposes, but for moving in the face of an enemy they are impracticable, as no officer would dream of telling off a company, when casualties were frequently occurring.

To quote Captain Mountsteven, with regard to the formation of threes, "it would have a bad effect physically, as after taking off your attention to no purpose, it would only enable you to do that which would be done better by filing; and a much worse, morally, by constantly reminding the men of the loss they were sustaining.

The manner in which I think the number of commands might be reduced to one, and the movement simplified, is thus:—On the cautionary word of command—

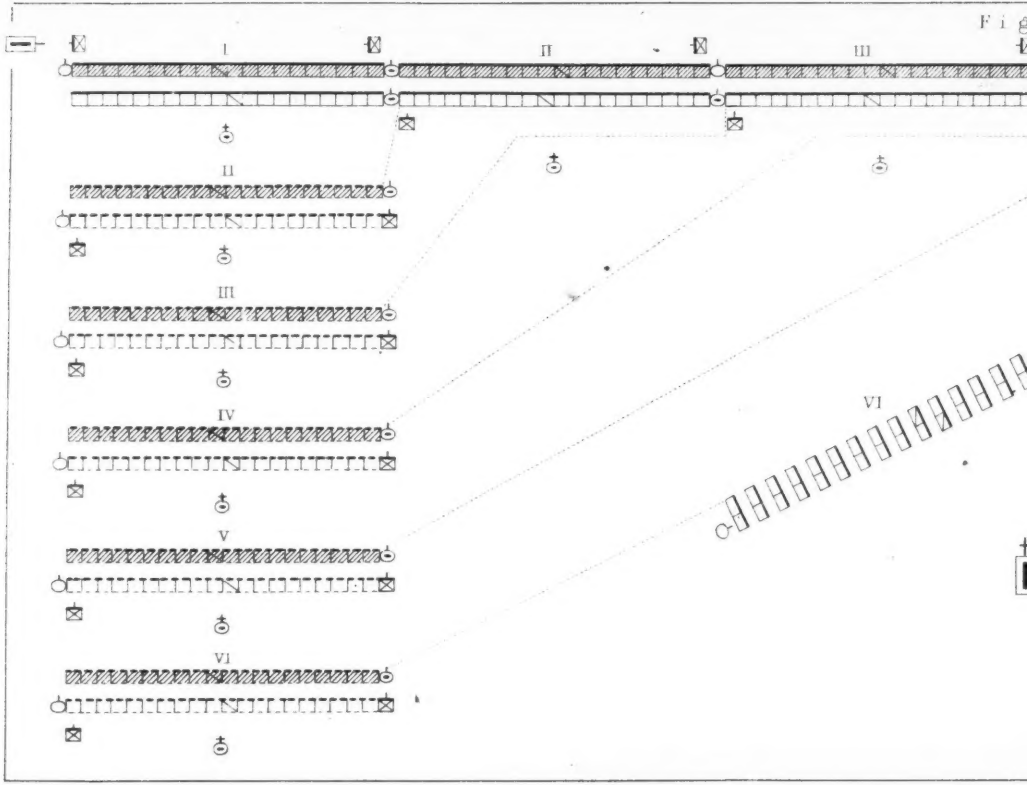
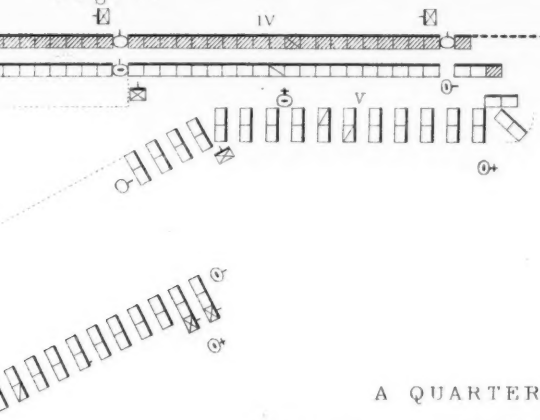

I
II
III
II
III
IV
V
VI
VI

Fig. V.



A QUARTER DISTANCE COLUMN

BY ITS RIGHT, DEPLOYING TO THE RIGHT OF THE

LEADING COMPANY OR ACCORDING TO THE PRESENT DRILL.

A Quarter Distance Column Right in Front

deploying on the Rear Company.

J.R.Jobbins.

Open, quarter, or *close column, right or left,*
" " " " *in front, right or left,*
" " " " *inwards,*

the whole, excepting the company on the flank denoted, would face in that direction. On the word "*Quick march,*" supposing the formation to be *Open column right,* the remaining companies will move off led by the officer who happens to be on the right; the right covering sergeants (that is the sergeants in rear of the right of companies), excepting those belonging to the company upon which the formation takes place, will double out and take up the point where the left of the companies will rest in column. The companies will pass round the covering sergeants as at present, and will halt and front in succession by files as soon as the leading file has closed on the officer, who will halt and front the moment he finds himself square to the front.

Should it be necessary to form the column in front of the left, the word of command will be "*Quarter distance column in front, left,*" upon which the whole, excepting the left company, will face to the left. On the words "*Quick march,*" the left covering sergeants will double out, and mark where the right of the companies will rest, and so on, as in the previous movement.

Deployments.—The present system of deployments, although easy to the eye, is dependent on too many aids and contingents. For instance, should, in the heat of action, the captain of No. IV not hear the "halt, front, dress" of the captain of No. V, in deploying on a rear company, he will march further than required, and at once cause a break in the formation, which, as often is the case, may be expected to open fire at a critical moment. The constant warning of the sergeant-major, that three files are out from the right of No. IV or VI, proves also that the intermediate movement is wrong in principle.

Premising that the equality of ranks has been established, it enables deployments to be immensely simplified, so as to ensure their accomplishment under fire, either from the halt or on the march; the latter being an advantage of which a commander is deprived. At present there is no possibility of a battalion advancing in a compact form, like close or quarter distance column on an enemy, and suddenly deploying whilst on the march, a favourite mode of attacking with the French.

The second advantage secured by not studying the order of companies is, that it does away with that showy but complicated and slow movement of deploying on a rear company, as all deployments, according to the system proposed, will take place on the front; and, lastly, it enables men to open fire the moment a file has formed up, without waiting for the whole company. The command would be simply—

"*Deploy right,*"
" *left,*" or
" *outwards.*"

On the word "*Deploy right*" (Fig. V, Plate XXIII), the whole, excepting the leading company, will face to the right, or form close column of subdivision. At the word "*Quick march,*" No. II will wheel smart to its left, led by the officer that happens to be on that flank; and on the front rank man of the leading file being in line with the rear rank man of the

right file of No. I, he will halt, and his rear rank man will form in front of him, and so on in succession, or in other words No. II will right front form company. The remaining companies led in the same way, will move up and along the rear of the company already formed up, and on the front rank man of the leading file arriving in line with the last file of the preceding company, will form company on the leading file to the left, only with reverse ranks. If desirable for parade purposes, covering sergeants may double out in succession, and take up points. The captains will always superintend the heads of their companies. *Deploy left* will be done in the same way. *Deploying outwards*, which will take the place of deploying on a central company, will be effected in the following manner:—On the word "*Deploy outwards*," the leading company will stand fast, Nos. II, IV, VI, and VIII will face to their left; Nos. III, V, and VII will face to their right. On the word "*Quick march*," even numbers will deploy as a company deploying left, odd numbers as a company deploying right.

Another advantage obtained by deploying in this manner is, that if the formation is taking place under fire, that the intermediate movement is to a certain extent screened by the companies already formed up, an advantage not to be undervalued, as it tends to keep men cool and collected, and give their attention to the formation they are expected to accomplish.

Squares.—The few instances that we have of squares being broken by cavalry renders it more useless than ever, and a waste of time in forming them four deep, particularly when we consider the long range of rifles, and the superior practice of infantry. In fact, it may be said that by the introduction of breech-loaders, which must take place shortly, the necessity of forming squares at all will be very much diminished. It is a formation which is extremely cumbersome and dangerous, particularly when we take into consideration the preponderence of artillery in proportion to other branches of the service that modern armies are expected to have. One battery of 6 guns and two howitzers to a brigade of 5,000 or 6,000 used to be the proper complement in most foreign armies; now it is more than treble, and in many cases more than that.

The word of command for forming square would be simply, if in line, *Form square, right, left,* or *centre;* if in column, *front* or *rear.*

If in quarter distance column, on the caution *Front form square* (Fig. VI) companies Nos. I and VIII will stand fast, Nos. II, IV, and X will face to the left, Nos. III, V, and IX to the right. On the word *Quick march*, Nos. II and III deploy on No. I, Nos. IX and X deploy on No. VIII, No. IV forms the left, No. V the right face of the square, Nos. VI and VII form the reserve, and Nos. VIII, IX, and X will close the square; Nos. IX and X in deploying on No. VIII, will deploy as on the march by Nos. IX and X, breaking into double time till formed up.

If in line, on the caution *Form square left*, the whole, excepting the three companies on the left flank, will face to the left. On the word *Quick march*, No. VII will move close along the rear of Nos. VIII, IX, and X, and left front form company; No. VI, the leading file, will halt, face to the rear when in line with the front rank man on the left of

Fig. VII.

A Battalion in Line forming Square in Rear of the Left.

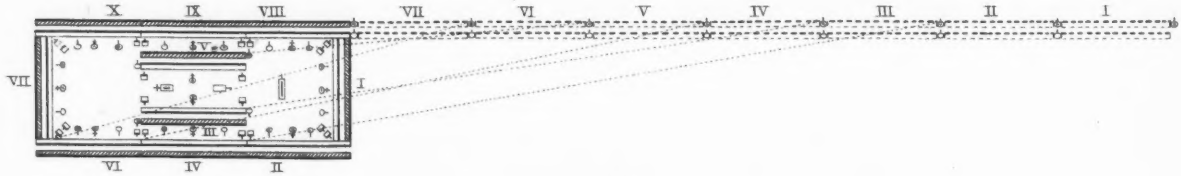
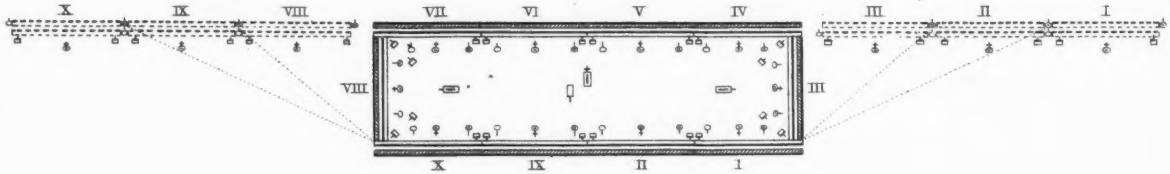


Fig. VIII.

A Battalion in Line forming Square, without Supports, in the Rear of the Centre.



J.R.Jobbins

No. VII, and so on in succession; No. V will halt and front in close column distance when in rear of No. IX, No. IV will form up like VI on the left of that company, No. III will halt at close column distance and face to the rear, in rear of No. IV, No. II will form as No. VI, but on the left of No. IV, No. I will close the square by forming company to the right about on the leading file.

On the caution *Re-form column*, No. I will stand fast, Nos. II, III IX, and X will face inwards; No. IV will face to the left, and V to the right; Nos. VI, VII, and VIII will face about. On the word *Quick march*, Nos. II, III, IX, and X will form column in rear of Nos. I and VIII, No. VI will halt in rear of No. III, and No. VII in rear of No. VI, No. IV in rear of No. VII, and No. V in rear of No. IV.

Fig. VII, Plate XXIV, illustrates a battalion in line forming square in rear of the left with supports in the centre, according to French system.

Fig. VIII represents a square, without support in the centre, formed by a battalion in line in rear of the centre, a formation which has the double advantage of being quickly and easily formed, as well as changed into any other formation.

Lastly. *By wording all commands in such a manner as to clearly indicate what the next movement will be.*

As the object of this must be obvious, it will be sufficient if I place side by side an old and proposed new word of command.

Instead of *change front on the centre, right thrown forward*, I would try and assimilate company with battalion command, and say *company* or *battalion on the centre right wheel.*

In conclusion, I beg to add that I sincerely hope that the system I have this day attempted to advocate may not suffer by the imperfect manner in which I have illustrated it.

Question by Capt. PACKE: Who is answerable for the distance in column?

Answer: The officer on the pivot.

Question by Captain BENNETT: Why are the subalterns placed one in front and one in rear?

Answer: To divide the superintendence, and denote the pivot more clearly.

Question by General STANHOPE: Are both ranks to be equal?

Answer: Yes; in every respect.

Evening Meeting.

Monday, May 2, 1864.

Colonel P. J. YORKE, F.R.S., in the Chair.

NAMES of MEMBERS who joined the Institution between 25th April and 2nd May.

ANNUAL.

Pratt, Lord Geo. M., Lieut. Gren. Gds.
Garratt, J. A. T., Lieut. Gren. Gds.
Trotter, Henry, Lieut. Gren. Gds.
Thomas, C. D., Lieut. Coldstream Gds.
Lewis, G. O., 7th Royal Fusiliers.
Rycroft, C. A. W., Cornet Hants Yeo. Cavalry.
Colvin, W. B., Capt. 7th Royal Fusiliers.

ON THE EMPLOYMENT OF CAST-STEEL FOR THE MANUFACTURE OF ORDNANCE AND PROJECTILES.

By H. Bessemer, Esq.

From the time when the highly expansive force of gunpowder was first discovered down to the present, the material best adapted for the construction of ordnance has occupied the attention of the artillerist.

The employment of bronze for this purpose at one period had become almost universal, and it was not until the time of Elizabeth that guns were founded in iron at Tunbridge, of a quality calculated to supersede those of bronze. Since that period, however, the employment of iron in the manufacture has gradually extended, until it has almost wholly replaced the more expensive alloys of copper.

As it would be entirely foreign to the purpose of this paper to give even a sketch of the early history of artillery, we may at once turn our attention to the present state of that manufacture.

Cast iron as a material for ordnance possesses some advantages which it is impossible to ignore; it is inexpensive, and can be founded with great facility even when of the largest size. The simplicity of structure, arising from founding such guns in a single mass, is no mean advantage; in these guns there is no delicacy of structure, nor are there any fine parts to give way or spoil by a slight corrosion; these

are points of no little importance in the rough necessities of actual warfare, indeed in this respect they stand far above the modern built up wrought-iron gun. Cast iron, when of the excellent quality made by the Low Moor Company, has proved itself a most valuable material for the artillerist; it does not, however, combine in itself all the qualifications essential to the perfection of modern ordnance and projectiles. When large masses are founded, crystallisation takes place very slowly; these crystals are more or less perfectly developed, and their coherence is consequently diminished in the same ratio; the grain of the metal becomes open and porous, while some of the carbon in the form of graphite, separate more or less from the metal, and by interposing itself between the crystals, still further weakens their hold one upon another.

Many attempts have from time to time been made to improve the quality of iron for the gun founder, and not without a measure of success. At the Royal Gun Foundry in Vienna, a reverberatory furnace, known as Ecke's furnace, is employed to melt and refine the metal. In this furnace carbonic oxide gas, generated in an adjoining chamber, is employed; jets of this gas and atmospheric air are introduced into the melting chamber, and when the fusion of the metal has taken place on the circular hearth, two jets of air are forced diagonally upon the surface of the metal, from opposite sides of the furnace, so as to cause a slow rotation of the metal on the hearth, and thus bring every portion in turn under the influence of the jets, the result is a certain degree of purification of the metal, which is said to considerably increase its tenacity, and otherwise render it more suitable for the founding of ordnance. The re-melting of iron several times in succession appears by the very interesting experiments instituted by Mr. William Fairbain, also greatly to improve its tensile strength; the effect upon the metal and its constituents being practically much the same as that produced in Ecke's furnace.

Among the improvers of cast iron the name of Morris Stirling holds a prominent position. This gentleman's invention consists in melting wrought iron scrap, with cast iron, in the cupola furnace; by this means it is probable that a higher degree of refinement is given to the metal than could be attained by either Ecke's furnace or by a succession of meltings. This invention of Mr. Stirling's would have well repaid a further investigation, and deserves more success than it has met with; doubtless the difficulty of fusing the wrought iron in the cupola furnace, and the uncertainty of the mixture arising from that cause, has prevented its more extended use.

Another mode of improving the quality of cast iron for founding purposes has lately been introduced, the application of which to the founding of ordnance would be most interesting. For this purpose iron as highly carburetted as possible is preferred, because such iron, by melting in the blast furnace at a lower temperature, is more pure than metal obtained from the same materials in a less carburetted state. When this metal is in a state of fusion, from one-third to one-half of its weight of molten malleable iron, or molten steel, may be poured therein, direct from the Bessemer apparatus, and be then

mechanically stirred together, the mixture taking place in a casting ladle placed on a suitable weighing machine, so that the exact quality of metal desired may be arrived at by accurately weighing the crude and malleable metal before mixing them together. The highly carburetted condition of the pig iron admits of a large proportion of the malleable metal being used therewith, without rendering it too hard for founding purposes.

This mixture of steel with cast iron not only gives a very fine and close grain to the resulting metal, but it entirely prevents the separation of carbon in the form of graphite during its cooling and crystallisation; it may be cast in ordinary sand or loam moulds with the same facility as ordinary cast iron, while its resistance to compression and its tensile strength are very greatly in excess of any known quality of that metal. One of the stamp-heads employed for crushing quartz, made of this mixed metal by casting in an iron mould, is before you on the table; it contains a few air bubbles, in consequence of the rapid cooling of the metal in an iron mould. One end has been broken off in order to show the beautifully fine grain of the metal, which is semi-malleable, and capable, at a blood-red heat, of being hammered from a 6-inch bar to a 5-inch one, without fracture.

For the construction of mortars and ordnance designed to throw spherical shot or shell, and where the strain on the material is not excessive, this simple and inexpensive mode of founding ordnance in a semi-malleable metal may lead to important results. The founding of ordnance in steel and the employment of it in its cast or unforged state, does not, however, appear to offer the advantages which the application of so excellent a material as steel would lead one to expect. It must also be borne in mind, that the casting of this metal in large masses is attended with great difficulty, and its soundness and freedom from air bubbles is by no means easily insured. These difficulties in founding steel have, however, been lessened to a very great extent, if not wholly surmounted, by Messrs. Naylor, Vickers, and Co., of Sheffield, who have made great progress in the art of founding in that metal, but there still remains the fact, that steel as cast, and while still in the unhammered state, possesses only about one-half of the cohesive force which the same piece of metal will acquire when hammered or forged, nor will a cast bar bend without fracture more than 4 or 5 degrees from a straight line, but when hammered it may be safely bent to an angle of 45 or even to 90 degrees without giving way. When therefore we consider how small is the labour and expense of hammering a mass of cast steel, and that its resisting powers may be doubled by that means, it will be seen that its use in the unhammered state should only be resorted to in cases where the shape of the casting renders hammering extremely difficult or impossible.

The difficulties felt by the artillerist in obtaining cast guns capable of withstanding the severe strains which the system of rifling and the employment of elongated projectiles necessarily entail, has forced their attention to the best means of employing malleable iron in the construction of ordnance. All attempts to effect this object on a large

scale are attended with great difficulty, and uncertainty as to the final results, however good in its original state the bar iron may be that is intended to be made into a massive forging. We have no positive assurance that the same excellence of quality will survive the repeated heatings and hammerings, which it is destined to undergo, before the forging operation is complete; nor can we tell how much of the oxide which accumulates on the surfaces of the bars may be shut up between them, and produce flaws and weak parts in the forging; nor is it easy to determine to what extent the contractile forces of the mass in cooling will induce strains, tending to rend open the interior of the mass.

As the forging proceeds from day to day, and week to week, its temperature rising and falling with every fresh "heat," and its particles undergoing a continuous change of position, by the alternate expansion and contraction of the mass, as well as by the blow of the hammer, need we wonder that the natural tendency of iron to assume the crystalline form (when favoured by excessive heat and motion among its particles) is felt throughout the mass, which gradually looses its peculiar fibrous texture, and becomes more or less crystalline. The law of crystallisation by which the size of the crystal is governed by the size of the mass of matter, and the time occupied in the formation of them, has its full effect in this forging operation, and not unfrequently produces crystals, whose planes are nearly an inch in extent, and so distinct from each other, as to require but a small amount of force to separate them; with all these sources of difficulty in the way of the manufacture of heavy wrought iron ordnance, it is almost impossible to appreciate sufficiently the successful manufacture, by the Mersey Steel and Iron Company, of the monster gun manufactured and presented by them some few years since to the British Government, at once a monument of official apathy and neglect, and of the skill and enterprise of its manufacturers. In order to avoid the difficulties of producing large masses of forged iron, many plans of building up wrought iron guns have been proposed, among which the plan adopted by Sir William Armstrong has come most prominently before the public; the gun in this case being composed of a series of cylinders, formed by coiling a bar of wrought iron around a mandril, and then welding the adjacent sides of the coil together; it is quite clear, that by so doing much of the danger attending the forging of the large mass is avoided; it is true the welding heat, also necessary in this case, may deteriorate the metal more or less, but it is not likely to do so to the extent which is almost unavoidable in forming a large solid forging, the grain or fibre of the metal is moreover laid in such a direction as to obtain the greatest resistance to the bursting of the tube, but for these advantages, how much is sacrificed! the simplicity of the structure is entirely gone, the skill and labour of boring, and fitting accurately, successive rings over each other, adds enormously to the cost of guns so constructed, and unless each of these fittings be perfect, the coils may be acted on, one at a time, and so becomes destroyed piecemeal. If the contractile force of the metal forming each coil could be perfectly adjusted in the first

instance, and never afterwards underwent a change by constant firing, or by the heating and cooling of the gun; then bar iron might in this way be advantageously employed. But we find these wrought iron tubes so long and pertinaciously adhered to now giving way to tubes of cast steel, over which little coils of the weaker metal iron are fitted, thus keeping up the semblance of the original Armstrong mode of construction, while its principle is thus practically ignored, even by Sir William himself.

With reference to iron, such as that employed in the form of square bars for the Armstrong gun, it may be observed that there are many practical men who still believe that the welding of the several pieces of which the original pile is composed, is so perfect, that the pieces constituting the bar have become one; such persons hold that an *union*, and not a mere *adhesion*, of the surfaces has taken place; this, however, is not the case, for bar iron of the highest brand made in this country, has been repeatedly tried, and as repeatedly has utterly failed to hold together, when subjected to the amount of fatigue which the Bessemer steel stands with impunity. We have before us a portion of an iron bar of a justly celebrated brand; this bar, if worked at a welding heat, under ordinary circumstances would have held together, and might have been fashioned successfully into any article required; but instead of this, the bar was submitted to the action of a sharp, quick, hammer, giving from 300 to 400 blows per minute, the heat being a full red, but a little below the welding point, so that *no* new welding of the parts takes place as the work proceeds; no piled metal *can* withstand such severe fatigue, all the old joints soon begin to open up, and long before the section is brought down to half an inch square, it becomes simply a bundle of fragments; from this it is clear, that if a welded joint were really a true union of the metal, this splitting up could never take place. To show, however, that mild steel is capable of enduring a vastly greater amount of fatigue, a bar of ordinary mild Bessemer steel was submitted at the same temperature to the same hammer, but although reduced to less than one-two-hundredth of its original bulk, it is still without a flaw, indeed, such a separation is as utterly impossible in cast steel, as solidity is an impossible condition in piled or welded iron. The future must determine whether the repeated concussions to which a gun is subjected when in use will produce a similar disintegration of the numerous joinings that pervade the entire structure. Among all the various conditions under which the metal iron is known in commerce, none appears so entirely to combine in itself the qualities essential in the construction of ordnance, as are found in well hammered mild cast steel. The resistance of cast steel to compression, according to the American experiments, quoted by Mr. Mallett, has a mean of 295,000lbs., that of cast iron, 125,000lbs., and wrought iron, 83,500lbs., while the tensile strength which these materials are capable of resisting may be taken at 40 tons for mild cast steel, 20 to 25 tons for wrought iron, and 10 to 12 tons for cast iron; thus we find in cast steel a material not only capable of resisting a compressive force far greater than any other known metal, but one whose tensile strength is also

nearly double that of wrought, and more than three times that of cast iron; perhaps in no other point is the advantage of steel over wrought iron more marked than in its power to resist compression, a property to which it would appear that cast iron, so low in tensile strength, owes chiefly its power of resistance.

It will be unnecessary to enlarge further on the well-known fact of the superior strength of cast steel, as compared with iron, in any form in which that metal is known, but it may be interesting to examine its comparative merits, on other points equally essential to the perfection of a material for ordnance. For rifled ordnance, the metal of which the gun is composed should be capable of resisting to the greatest extent possible the wear and abrasion of the rifle grooves, caused by the passage of the shot along them. If we may take as an example the wear of a steel piston ring, or a steel piston rod, or a railway tire or rail, we find that steel has a power to resist abrasion from five to ten times greater than that possessed by wrought iron.

Again as to flaws and surface cracks, caused by the imperfect union of the numerous pieces of wrought iron composing a gun, it may be truly said, that no amount of human skill can prevent the formation of flaws or cracks of greater or less magnitude in the mass of wrought metal, these crevices sometimes outcrop at the most unfortunate point, they not only weaken the metal, but give rise to the fouling of the gun, and when large, may harbour a spark, and do much mischief. In a cast steel gun made from a *single ingot*, all such defects are *simply* impossible.

Another point of considerable importance in the choice of a material for ordnance, is the amount of destructive action which will result from corrosion, for in the rough usages of war, guns will not be so tenderly looked after as on practice days at Shoeburyness, and we must not then expect to look through a delicately polished tube, which delights the eye with a succession of beautiful rings of reflected light; a few months in the trenches, or exposed to the damp saline atmosphere of the sea, assisted by the chemical action of explosive gases, will soon corrode and roughen the interior of the gun. Wrought iron, in consequence of its peculiar formation, presents on its surface innumerable fissures, which, though not visible in some cases to the eye, nevertheless exist. The imperfections of welding which pervade every portion of the wrought mass, produce multitudes of crevices which crop out side by side, and show clearly how the original pile was formed, corrosion follows up in all these little fissures, widening and deepening them, and thus rendering the surface corrugated and uneven. We have only to examine any wrought iron structure that has been exposed to air and moisture, or an old cable, or anchor, and mark its deep, indented surface, to see this fact illustrated.

Cast steel, from having been once fluid, and cast in an undivided mass, is wholly free from this uneven action, when exposed to corroding influences. The two square bars before us afford an example of the different behaviour of the two metals, under precisely the same treatment; one of them is a bar of good ordinary wrought iron, known

as S C iron, the other of Bessemer steel, both were planed true and polished, the ends neatly squared, and the angles left sharp, they were both fastened to a wooden frame, and immersed simultaneously into a vessel filled with a corrosive fluid, consisting of one part of sulphuric acid with ten parts of water, and there left for forty-eight hours; the natural result is, that the iron bar has corroded unevenly, showing clearly the structure of the pile, and exposing to view every welded joint; while the steel has lost only a portion of its outer surface, its figure, with every angle sharply defined, still remaining intact. It is somewhat remarkable that this corrugation of the surface of wrought iron when corroded has not been more considered in reference to the Armstrong gun, where the corroded lines would be nearly at right angles to the rifled grooves, while the angles of the grooves themselves would become serrated, like so many saws. The effect upon the lead-coating of the shot, which even an approach to this condition would produce, can be easily imagined; the advantage which the Whitworth form of rifling presents in this respect is most important; even if he employed wrought iron, the amount of corrosion which would utterly destroy the Armstrong gun, would take little, if anything, from the efficiency of the gun of Mr. Whitworth; but it must be remarked, that this gentleman has advocated and employed cast steel from the commencement, while Sir William Armstrong has as constantly resisted and opposed the employment of a material which, if adopted, would have entirely swept away and rendered valueless his whole system of welded iron coils, and at the same time have deprived him of the monopoly he has so profitably enjoyed.

In order, however, to compete with Mr. Whitworth, it is stated that the very *heart* and *core* of the Armstrong competing gun is made of cast steel; if this be so, the present trials afford no test whatever of what the country is most anxious to know, namely, what are the real capabilities of the coiled and welded iron tube, on the manufacture of which such a vast amount of money has been expended.

To return, however, from this digression, to the consideration of cast-steel as a material for the construction of ordnance; it has already been shown that its tensile strength, and resistance to compression, its freedom from wear and abrasion, its perfect freedom from cracks or flaws, and also its behaviour under corroding influences, offer the most important advantages over wrought iron; it therefore only remains to be seen, if ordnance made of so desirable a material can be produced with more or less ease and certainty than guns constructed by forging, or building up, in wrought iron. Although cast steel is not a new material in the arts, yet cast steel of the mild character approaching to iron, such as alone should be employed for ordnance, is not easily obtained, by the ordinary process of melting steel in a number of small crucibles, more especially where large masses are required; but notwithstanding these difficulties, the fact that large masses of steel can be made successfully by such means, was abundantly proved by Mr. Krupp at the International Exhibition, where he achieved a success, which still leaves him without a rival, in the manufacture of large masses of crucible steel. It must be

observed that Mr. Krupp not only has made large masses of steel, but he has successfully fashioned them into guns, of which the Prussian Government alone are said to have more than 1,000 of various calibres.

It is stated on reliable authority, that the employment of steel guns in actual warfare, before Dyböl, has been so successful, that the Prussian Government, within the last week, have ordered an additional 300 guns from Mr. Krupp.

The extreme toughness which results from reducing the quantity of carbon in steel to the lowest point, while it greatly increases the risks and difficulty of making large masses of steel in separate crucibles, in no way interferes with the making of steel by the Bessemer process, where the heat generated during its conversion is sufficient to retain the metal in a perfect state of fusion, even when wholly decarbonised and converted into soft malleable iron; so that only as much carbon need be added thereto as will suffice to bring the metal up to the particular quality of steel required. A quality much milder and nearer approaching to iron, than has yet been employed, is deemed by the writer to be indispensable for that purpose, for even wrought iron appears to fail more from its structural imperfections, than from any want of hardness in the metal.

Of all the errors and misconceptions that the public have fallen into in reference to the Bessemer steel process, there is none so utterly without foundation as the idea that this process is incapable of perfect control, and that the results obtained are involved in uncertainty.

In the early stages of so novel an invention, and at a time when not a single workman could be found who understood even the merest routine operations, and when no one possessed the advantages which experience alone can give in manufacturing operations, it need not be matter of surprise, if the results then obtained were not very uniform, and the trade, who had to a man declared the whole process an impossibility, eagerly seized on this fact, which was industriously circulated, and at the same time, like most stories, it lost nothing by the telling. A cry once raised seems to echo, and repeat itself, with redoubled force, although the fact which originated it has long since ceased to exist. One of our first practical engineers, who has used more than 2,000 tons of the Bessemer steel, asserts that it is considerably more uniform in quality than ordinary cast steel, indeed the manufacture as it now stands leaves but little to desire. This cuckoo cry, of want of uniformity, has, however, done some good; for it has caused a strict investigation into ali the possible sources of irregularity, and has enabled the writer to effect such an improvement in this process as bids fair in future to turn the tables on its accusers, who cannot hope by the mere examiuation of their steel by the eye, and thus judging of its state of carburation, to arrive at the certain results to be obtained by a system of accurate weighing.

In the Bessemer process as generally practised, the crude metal is entirely decarbonised, and is then brought back to the state of steel, by the addition thereto of a certain quantity of molten carburet of iron. In practice there are several sources of slight error in this system,

which are found generally to counteract each other to a great extent, but which sometimes may possibly alter the quality of the metal to an undesirable extent. Thus, suppose that five tons of pig-iron, constituting a charge, are weighed up for the melting furnace, this pig metal may consist of 94 per cent. of pure iron, combined with six of carbon and other matters, or there may be only 93 per cent. of iron present in the pig. The furnace-manager may loose five, or he may loose six, per cent. of the metal in melting it, a little metal may also be sometimes left in the bottom of the melting furnace and in the gutter, the loss in the converting process may also vary from one-half to 1 per cent. more or less than usual, and some half per cent. of metal may be accidentally thrown out of the vessel in the form of splashes; hence, although five tons were weighed up, the exact weight of the malleable iron resulting therefrom is more or less uncertain, and consequently the precise quantity of carburet of iron, to be added thereto, cannot be accurately ascertained. At first sight it would appear that 1 cwt. of metal more or less lost in several ways, and amounting in the aggregate to a quarter of a ton, in error of the supposed quantity, would seriously affect the quality of the steel; it however does not do so, for as no metal can be gained, we may assume that 500 cwt. in error is a maximum of unknown loss, if then we take a mean, and estimate the source of error at one-half that quantity, by no unfortunate combination of circumstances can there be more than an error of $2\frac{1}{2}$ cwt., or one-fortieth of the charge of 5 tons. Now in making a very mild steel, about 0·33 per cent. of carbon is required, say 1-300th part, thus the extreme difference in the quantity of carbon added to the metal would be $\frac{1}{12000}$ part too much or too little, a quantity quite recognisable as a chemical fact, but practically making no sensible change in the character or quality of the metal; should however the sources of error in the carburet of iron employed be equally great, and in the opposite direction, then a difference in quality to a small extent would show itself.

Now the first stage in the improvements before referred to, and which are intended to entirely remove these several sources of inequality, consists simply in accurately weighing the fluid malleable iron on a suitable weighing-machine, *after*, instead of *before*, these losses of metal have taken place, and thus removing in one minute, absolutely, every trace of the several sources of error above enumerated.

We next come to deal with the carburet of iron, which is to recarbonise this accurately-ascertained quantity of malleable iron. The carburet of iron is also subject to some of those small sources of quantitative error already described in reference to the pig iron, and also to some others in addition to them. In the first place, if we take four pigs of a carburet of iron, the quantity of carbon or manganese present may not be precisely alike in each pig, and in melting this metal, the quantity of carbon and manganese lost by oxydation in the furnace cannot be accurately estimated, and therefore although these numerous and minute sources of error are found practically to be neutralised by an average allowance of loss, it is nevertheless possible that they may all tend in one direction, in which case the difference in

quality of the metal would be more than is desired. To avoid every one of these sources of error in the carburetting metal, 100 tons of it may be melted in large quantities, and be then granulated in the form of shot, and be thoroughly mixed together. From this intimate admixture of granulated metal, every charge of 4 cwt. weighed up may be assumed to be of precisely the same quality. Now this shotted metal is not to be melted as heretofore, but heated only in an air-tight retort, where no manganese or carbon can possibly be lost, so that we have only to accurately weigh a proper quantity of this metal, and add it to the accurately ascertained weight of pure malleable iron, to obtain steel of a *pre-determined* quality, and if each of the 500 separate charges, which the 100 tons of shot will make, be added to 500 other charges of 5 tons of malleable iron, there will result 500 charges of *steel* weighing 25,000 *tons*, having an equality of temper or hardness, such as no other known process of steel-making has ever yet produced.

In manufacturing large masses of mild cast steel by the Bessemer process, nothing more is necessary than to melt some 20 or 30 tons of No. 1 hematite pig iron, in the ordinary reverberating furnace used for founding guns in cast iron, the furnaces when tapped, will run their contents into a converting vessel of some 10 feet in diameter, a powerful blast of atmospheric air is then to be driven vertically upwards through the fluid iron, for about 15 minutes, which will raise its temperature to the highest degree and convert it into malleable iron, which will then be in a state of perfect fusion; if then as much carburet of iron be added thereto as will give to the mixture about one-third of a per cent. of carbon, a very mild and tough cast steel will result, which may, after being stirred vigorously by a revolving agitator, be poured out into a mould, and thus, within half-an-hour of tapping the molten cast-iron from the melting furnace, a mass of some 25 or 30 tons of mild, tough, cast steel will have been produced, without weld or joint, and with a loss of only 15 per cent. of the pig iron employed in its production. Thus we have a means of rapidly and cheaply producing huge masses of malleable metal, having the peculiar characteristics which are found to be most desirable in a material to be used for ordnance. And here it may be as well to recall the fact to your notice, that the degree of heat required to extend and shape this mass under the hammer, or hydraulic press, is so far below the heat necessary for welding masses of iron together, that there is no danger whatever of bringing the steel so near the point of fusion as to produce the peculiar crystallised condition so difficult to avoid, and at the same time so destructive to forgings in wrought iron.

It has been found that large masses of cast steel, made by the Bessemer process, may be most advantageously treated under the hammer almost immediately after they have been cast, since at that time the interior of the mass is at a much higher temperature and consequently softer than the exterior of the mass, this allows the blow of the hammer to act efficiently on the central parts of the ingot, and thus remove the only difficulty that stood in the way of operating on large masses of cast steel. Before this important fact was proved, the invariable rule in Sheffield was to let every ingot get cold after

casting, and never to touch it under the hammer until the next day. Indeed the steel manufacturer went much further than this, for it was not uncommon to stack the ingots for months out in the weather to season them, like the old glass-maker used to do with his fritted materials, and never use them until a year after. When large masses of steel are heated after being allowed to get cold, the external parts are apt to become injured, and in all cases it will be found that the outside is always hotter and softer than the centre. It is therefore hopeless to attempt to properly reach and extend the hard centre of the forging, when it has a soft exterior to absorb the blow. It is difficult to determine whether this system of letting the ingot get cold before hammering is merely one of the deep-rooted prejudices of the trade, or a defect common to the old system of steel making; be this as it may, it is a fact, that more than one hundred pieces of ordnance have been made of Bessemer steel, and forged *hot* from the casting with perfect ease and success.

About a year ago a Mr. Thompson, of Bilston, obtained a patent for a new mode of making gun-barrels, of this material, by a series of very simple and efficient operations, examples of which he has kindly forwarded for your inspection. The steel is first hammered from the cast ingot into round bars, which are sawn into lengths. He then proceeds to punch a hole lengthwise through the mass, not by cutting out a portion of the metal, but by displacing the material. This is effected by using a blunt elliptical ended punch, which he drives through the mass of steel, under the steam-hammer. This is found to be a very severe test of the metal, a faulty piece being at once detected; indeed, it is probably a much more severe test of the metal than any that can be given at the proof-house. After the punching is effected, the pieces are drawn down a little under the hammer, and are then rolled between grooved rolls, which are provided with recesses, into which one end of the barrel is placed, so that the end is gradually shaped as required, the projecting part of the barrel being formed out of the solid, without any welding; he thus avoids the injury done to the metal by giving it a welding heat after the piece has received all the hammering required; these unwelded steel barrels can be produced at about 20 per cent. less cost than the best iron ones. Their extraordinary endurance under fire will be appreciated by reading the annexed report of their trial at the proof-house, Birmingham.

Trial of Two Steel Gun Barrels (Enfield Pattern), at the Proof-house, Birmingham.

Barrels made from Bessemer Steel by Thompson's Patent process.

Barrels, 1853 Infantry Pattern, 577 bore. Bullets used, 715 grains. Diameter, ·551· Length, 1·043. Ratio of length to diameter, 1·893.

Result of experiments:

1st round,	charge 205 grains,	7½ drachms powder,	1 bullet.
2nd round,	charge 224 grains,	8¼ drachms powder,	1 bullet.
3rd round,	„	„	2 bullets.
4th round,	„	„	3 bullets.

5th round,	charge 224 grains,	8¼ drachms powder,	4 bullets.
6th round,	„	„	5 bullets.

The barrels were now examined and found intact.

7th round,	charge 224 grains,	8¼ drachms powder,	6 bullets.
8th round,	„	„	7 bullets.
9th round,	„	„	8 bullets.
10th round,	„	„	9 bullets.
11th round,	„	„	10 bullets.
12th round,	„	„	11 bullets.
13th round,	„	„	12 bullets.
14th round,	„	„	13 bullets.
15th round,	„	„	14 bullets.
16th round,	„	„	15 bullets.

Barrels found intact.

17th round, charge 224 grains, 8¼ drachms powder, 16 bullets.

The firing was now continued with one barrel only, the nipple having been blown out of the other, which, still retaining its charge of 16 bullets, remained intact.

18th round,	charge increased to	269 grains,	9¾ drachms	powder,	17 bullets.
19th round,	„	„	„	„	18 bullets.
*20th round,	„	413 grains,	15 „	„	and 25 bullets.

Length of each bullet 1·043.

The barrel was then examined and found intact.—Further test was deemed unnecessary.

Proved by Mr. Samuel Hart, Assistant Proof-Master, *in the presence of Ezra Millward, Esq., Proof-Master at Birmingham, December 23rd, 1863.

These results may be taken as a fair indication of the nature of the Bessemer mild-cast steel, and of its applicability for ordnance.

However important a tough malleable metal may be for the manufacture of guns, it is not less so for projectiles intended to be employed against armour-plates or forts.

It is now more than three years since the writer obtained a patent for a machine for rolling cast steel spherical shot, under the full conviction that the time would arrive when the value of cast steel spherical projectiles would be appreciated.

The eight-inch spherical shot exhibited, are the first products of the first rolling-mill ever erected for the manufacture of spherical shot. A finishing mill to give them the last touch, would polish and improve the surface, and give extreme accuracy of guage.

Some few trials have already been made of the Bessemer steel shot with more or less success. A singular misapprehension appears, however, to prevail in reference to them. Some of the trial shot sent in by the manufacturers of Bessemer steel, were said to be too mild or soft for the purpose, and consequently not equal in penetrative power to some shots made of a harder temper, by the old and expensive mode of making steel in pots. Now the simple fact is, that nearly all the Bessemer steel now manufactured is of a very soft or mild quality, because a mild tough metal is indispensable when employed for the numerous engineering purposes to which that metal is now applied.

Thus it appears that a general impression prevails that Bessemer steel is naturally a soft, tough metal, but never hard or highly carbonised like other steel. This is one of those popular errors that

grow up unperceived, and for which there is not the shadow of a foundation, for there is not the slightest difficulty in carburetting Bessemer steel to an extent wholly impracticable with ordinary cemented steel. The Bessemer metal is made with equal facility, of any desired temper from the hardest and most refractory quality, by a series of almost endless gradations (at the will of the operator), down to the mildest cast steel, and beyond this point again to wholly decarbonised malleable iron, possessing nearly the softness of copper; it will be readily understood with what extreme ease and certainty this may be accomplished, if we consider that a given weight of wholly decarbonised iron requires 500 lbs. weight of a carburet of iron to be used therewith to produce the hardest steel, it is clear that 490 lbs. will make it one degree softer, and so on. By such marked differences as 10 lbs. at each step, we should have fifty tempers of steel instead of about ten as found in commerce.

The CHAIRMAN: I am sure the meeting will agree with me that our thanks are due to Mr. Bessemer for the very interesting paper he has read upon the application of his very original and economical method of making steel for the manufacture of ordnance. Seeing the excellent diagrams that Mr. Bessemer has exhibited showing the method he pursues in making steel, I think it would be interesting to the members present if he would be kind enough to explain the use of the vessels.

Mr. BESSEMER: The vessel AA, Plate XXV, used for the conversion of crude iron into steel by our process is mounted on axes, and is supported between two cast-iron frames C, the axes are so placed as to balance as nearly as possible its contents. The further side F is generally connected with some hydraulic apparatus, for the purpose of communicating a sufficient amount of power to turn it round with facility. A vessel of this kind weighs something like ten or eleven tons, and it holds five tons of metal, so that hand labour for turning it would be impossible. Again, the different speeds at which it must be moved as it approaches the pouring point, prevent the application of ordinary machinery which moves with great regularity, and you would, therefore, pour out a very irregular quantity of metal. The vessel is lined with a very refractory material. The lining, when it is perfectly dry and baked hard, will stand something like eighty or a hundred successive charges without being worn out. When the vessel has been heated inside by a little preparatory fuel (the residue of which is turned out), it is placed in the position shown in the first diagram (see Plate, Fig. 1), and a spout, B, conducts into it about five tons of molten pig iron. Immediately the molten iron has been poured in, the spout is removed, and the hydraulic apparatus is put in operation. It quickly turns the vessel round from this position into the one shown in the second diagram, Fig. 2. We have a reservoir of air under pressure, and a large air-forcing apparatus which drives air into this lower chamber or tuyre-box as it is called. There are several clay pipes divided into ten or twelve passages, which project into the interior of the vessel through the lining. During the time of filling the vessel there is no air blown through these pipes, nor can the metal enter those holes because they are placed above its level. That enables us to pour in the metal quietly without interfering with the operation. Immediately we want to commence the converting process in this vessel, we turn on the air; and as the vessel is moved round on its axis the metal occupies the lower position, and would immediately run down into these apertures only that the pressure of air is always kept greater than the pressure of the column of metal at that height, generally twice the pressure is employed. The effect of the air now going through under a pressure of some 18 lb. or 20 lb., is, that the air escaping from that pressure into the fluid separates itself into millions of little globules. I have blown air under similar conditions into a large glass tank of water in order to view the operation; and if we assume that the same condition takes place in fluid iron we may safely say that countless millions of bubbles are produced from one of these jets. It is very much like drawing the cork of a champagne

BESSEMER STEEL

Positions of Converting Vessel in Filling and Blowing

Fig. 1.
Filling

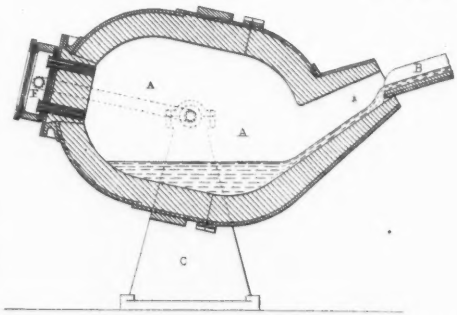
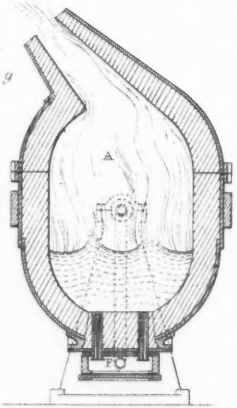
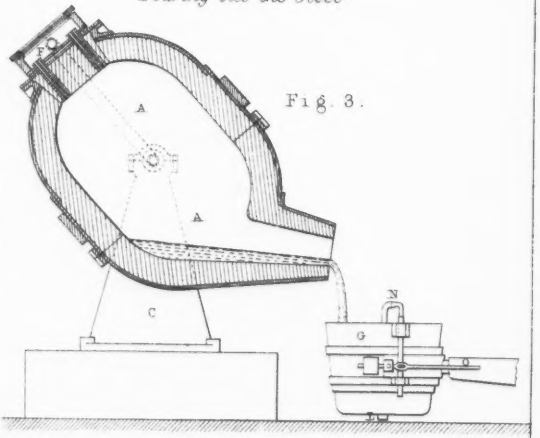


Fig. 2.
Blowing



Pouring out the Steel

Fig. 3.



J.K.Jobbins

bottle; the fixed air through the mass shows itself at every point. Here we have also these countless thousands of bubbles flowing upwards with great rapidity through the great mass of metal. As these escapes of air are taking place from something like ten tuyeres with twelve holes in each, we have one hundred and twenty jets, each producing those thousands of little globules. Upon the atmospheric air entering into the fluid metal, the oxygen of the atmosphere is necessarily brought into contact with the carbon of the pig iron. The result is a union of the carbon of the metal and the oxygen of the atmosphere, so that every one of these little air bubbles becomes a fire bubble. And as there is nothing between the fire so generated and the metal that surrounds the bubble and that forms the wall of each little cell or bubble, the heat so produced is absorbed by the iron, and as these bubbles are continuously formed at this great speed, an immense surface is exposed to the action of these little fire globules. On floating to the surface they entirely fill the vessel, which is eleven feet in height. And not only so, for they are projected out of an aperture thirty inches in diameter, and for some ten or fifteen feet in length we have a tremendous roaring flame, as white as snow and as bright as the sun, which is simply the accumulation of the fire produced from these globules. The result of thus highly heating the metal is, that instead of getting solid in its transition from pig iron into malleable iron, the temperature is kept up and we obtain an entirely new product, viz., malleable iron in large quantities in a state of perfect fluidity. A very singular thing takes place in the first stage of this process, which I may mention. Pig iron in addition to carbon invariably contains a notable amount of silicium. That silicium is a great enemy in iron; it is one of the difficulties of the ordinary manufacture. The affinity of oxygen for silicium is so great that it immediately seizes upon the silicium at first. Although I have described to you what is the action upon carbon, I should have told you, that before the carbon is touched at all, the oxygen of the air seizes on the silicium, which is burnt out with very little sign of flame, and only a few sparks from the iron, and with no visible increase of temperature until three or four minutes after blowing, when the silicium is all gone, the oxygen then takes the next substance in affinity, which is the carbon. In the early stages of this process, by the indications of the flame, we were enabled to judge with tolerable correctness when a proper amount of carbon had been taken out, so as to leave enough to constitute steel of a given quality. That was a process of the eye, requiring, like the old puddling process, many years of practice, and involving a great deal of uncertainty. The next step after the reduction of the metal to pure malleable iron, is the addition to it of a certain quantity of carburetted iron, by which the whole is brought back to steel of a known quality. When that has been done, the vessel is further turned on its axis until it assumes the position shown in the third diagram, Fig. 3. The stream of melting metal falling into a casting ladle G is shown in this diagram. The ladle is brought round on the arm of a crane and by means of a valve L in the bottom of the ladle actuated by a rod N which passes down the interior of the ladle, and is provided with a lever O so that a man who follows the ladle round lifts the handle, and allows a certain quantity of the metal to flow into the moulds, by which means any *scoria* floating on the surface does not form part of the ingot. Thus, we have here, what is very unusual in engineering operations, viz., a cone valve letting out molten malleable iron. These valves cost very little, but they can only be used once.

The CHAIRMAN: I understand you invariably procure your steel by purifying iron completely, and then introducing a quantity of carburetted iron of known composition?

Mr. BESSEMER: This is the mode practised in England. It is not so in Sweden. There is a very successful manufacturer of steel in Sweden who has made a beautiful quality of metal from high class ores by charcoal. He first saw the process in England, at the time when we had not adopted the re-carbonising of it at the end of the process. He went home to his own country to carry out a system he had seen so far successful with us; and by great attention to the subject, he has succeeded so well in watching the indications of the flame, and in taking time of the process (which is generally very regular, scarcely ever varying one minute in point of time), that he has been enabled to produce all the qualities of steel he requires, without re-

carbonising at all. The mode of regulating the temper or degree of hardness of the steel by the addition of molten carburet of iron at the end of the blowing process, was described in the first patent which I obtained for making steel by forcing air into crude iron, but was not practiced in the early working of the process.

The CHAIRMAN: We have several specimens of Swedish iron and steel in our Museum.

Mr. BESSEMER: There are some very excellent specimens in the Museum.

Mr. ASTON: Mr. Bessemer would oblige the members by giving a little more information with reference to the guns he spoke of, as having been made of his metal. I think he mentioned there were a hundred or more that have been made of the Bessemer steel. If he would kindly tell us something with reference to the weights and calibres of these guns, the information would be very valuable. I would also ask what steam-hammers are used for hammering the mass after it has been cast; and whether Mr. Bessemer has encountered difficulties in the way of hammering the mass, so as to ensure its being homogeneous—supposing the metal to be close and sound after it has been cast; whether during the process of hammering he finds that any portion of the mass deteriorates, whether some parts undergo any change which causes them to lose that uniform quality which I was very glad to hear he was able to impart to his metal? There is another point to which I am sure Mr. Bessemer's attention has been drawn, and that is the very great advantage which must necessarily arise from the use of the metal that he spoke of in all penetration trials against the armour plates, which will no doubt henceforth almost always form a portion of the structure in our navy. It is obvious that projectiles of steel must be used against armour-plates, and I should wish to know if Mr. Bessemer manufactures any particular quality of steel that he finds advisable to employ for penetration experiments. Different qualities of steel are employed by engineers according to the different purposes for which they employ it. No doubt for the crank axle of a steam-engine you would not employ the same quality of steel that you would for a shot that you wanted to send through a 4½-inch plate. If Mr. Bessemer can give us more precise information upon these points, I am sure the meeting will feel obliged.

Mr. BESSEMER: With reference to the first question the gentleman has asked, I am quite unable to tell him anything about the guns after they left my place. We have a shrewd suspicion (as they were delivered at Liverpool) that they went across the Atlantic. Upon that point I am unable to state anything further. With regard to the other questions, I am quite able to give the information he requires. In the forging of these guns, we have never found any difficulty in reaching the centre of the gun with the forging; and, I believe, entirely from the fact of our always using a large mass of steel in its hot state from the casting. When the fluid steel is poured into a cast-iron mould of some 2 or 3 inches in thickness, the quantity of heat rapidly absorbed from the exterior of the casting is such as to leave the outside rather too cool for forging, while the interior remains in almost a fluid state. Indeed, we have sometimes accidentally removed them from the moulds while the interior has been so hot that in laying them sideways they have poured out a little fluid from the interior. We find, for example, that when a piece of metal that weighs a ton, after it has been poured into the mould for about eighteen or twenty minutes, will have lost a sufficient quantity of heat to render it safe for removal. If you then put it into a furnace and warm the exterior a little, and allow the interior to lose more of its heat, at the end of twenty minutes in practice we find the ingot is in a right state for working. If you were to cut the ingot through with a cutter, you would find the inside of it at a white heat, a blow upon such a mass as that being received on the harder metal on the outside, and which becomes progressingly softer and softer as it approaches the centre, will transmit nearly the whole of its force to the central part of the mass, and it will not stretch most on the exterior as a bar ordinarily heated always does. That is one of the difficulties of forging that we get over. If you heat a large mass that has once been cold, you cannot get the interior up to the same heat as the exterior, the result is an imperfect forging. One rule we observe is this, the breech end of a gun, after the forging is complete, is drawn by a steam hammer into a bar 2 inches thick and 3 inches wide. That size is accidentally chosen, but if a bar so large as that will bend double when cold, it is certain that it is of good quality. A bar

2 inches thick and 3 inches wide can never be bent double if the metal has been burned. If we find it defective in this respect we do not send out the gun.

Captain SELWYN: What are the calibres of those guns?

Mr. BESSEMER: I think they have been guns of 12lb., 18lb., and 24lb. We have not bored them; we have merely sent out the blocks.

Admiral HALSTED: Are they for rifled guns?

Mr. BESSEMER: Yes, for rifled guns.

Mr. ASTON: What is the weight of the steam hammer?

Mr. BESSEMER: Those were forged with a steam hammer of two and a-half tons; a steam hammer of larger weight would have been better.

Admiral HALSTED: What would have been the weight of a bar?

Mr. BESSEMER: From 1 ton to 30 cwt. There is one question I did not answer about the quality of shot for penetration. That is a point in which we have had no experience. Like everything else it wants experience before we can speak with any certainty. We have hitherto made steel for other purposes of a mild, soft character; because it is used for engineering purposes, and any approach to brittleness is fatal. I know that some of that soft metal has been made into shot and fired at the armour plates. It has become a question whether that mild quality of steel is hard enough to do its duty properly. There is a point between the flattening up of a shot and the degree of brittleness that will make it fly into pieces; this is a nice point which practice alone can give. In my material there is no difficulty in arriving at any of these results which are desired, inasmuch as the metal used for carburation is now weighed and measured. As I said just now, if instead of adding 500 lb. to make a given quality, you add 490 lb., you have a less carburetted metal; and if you employ 480 lb., or 460 lb., and so on, you can by degrees get it so much softer. All that will be required, is to know the service for which they are to be used, and a dozen different tempers may be made as easily as one. A few shots of each quality can be tried against the material they are desired to penetrate; and those shot which stand the best, will give the necessary indication of the degree of softness or hardness that is required.

Admiral HALSTED: You do not show the application of the carburetted iron.

Mr. BESSEMER: The mode in which it is introduced after the metal has been converted into soft malleable iron is this: the vessel is turned again into the position shown in the first diagram, and at the moment it assumes this position, the air is shut off from tuyere box; and the carburet of iron is run in by the same spout that was originally employed to run in the pig iron in a molten state.

Mr. ASTON: The information which Mr. Bessemer has given us is of great value to all manufacturers of guns, but I should be glad to know how he is able to ensure that the amount of carbon which he imparts to his carburetted iron is retained by the mass, and that no portion of it is destroyed. Does he make any allowance for the combustion of some portion of the carbon he puts in, by mixing an extra quantity, so as to provide for waste in case it should happen? The fact that a uniform quality of steel can be made so as to be applicable to the manufacture of ordnance is a fact which I am sure all will be extremely desirous of believing, and desirous of seeing put into practical operation. That steel is used to a very large extent there is no doubt whatever; but it is well known that it is used at very great cost. If Mr. Bessemer by his process is able to reduce that cost, so as to bring the use of steel more largely within the means of the manufacturers of guns, he will assist them very materially, and the country at large will derive very great benefit, inasmuch as they will have cheap steel guns, instead of steel guns that are costly. With reference to the guns now being tried at Shoeburyness, both those of Sir William Armstrong and those of Mr. Whitworth have their inner tubes made of the metal whose use Mr. Bessemer advocates, namely, cast steel.

Mr. BESSEMER: With reference to the loss of carbon, in the ordinary way in which the process is now carried out, the fluid carburetted iron is poured in as I have described, and there we find we are subject to a little irregularity as to the quantity itself. In the first instance, we are not quite certain, in melting carburetted iron how much of the carbon in it may have disappeared in the process. That is our chief difficulty. Again, when a large quantity of carburet of iron is poured into fluid

malleable iron, a certain quantity of carbon always flies off, as we observe by the flame arising from the surface of the metal. But in the plan I now propose to use in all these cases, where extreme nicety is required in the quality of the metal, there will be none of these losses in the melting furnace, inasmuch as our carburet of iron will not be melted at all, but the metal will be heated in the form of shot. Those shot from having been mixed in great quantities will be absolutely uniform in quality. That is to say, taking a charge of three or four hundred weight of shot, there will not be less than from eight hundred thousand to a million separate pieces, and those separate pieces having been made of as uniform quality as possible, for all practical purposes the result will always be absolutely the same. In the addition of this red-hot shotted metal to the fluid malleable iron, none of the carbon flies off, in the same way as when using a large bulk of the fluid carburetted iron.

Admiral HALSTED: May I ask the meaning of the word shot?

Mr. BESSEMER: The carburetted iron in a fluid state is poured into water and the result is the formation of fine granules or shot, like the lead shot used for shooting birds.

The CHAIRMAN: Is there much difficulty in obtaining this carburetted iron? I suppose it is necessary it should contain nothing else but iron and carbon. Is there not some difficulty in obtaining such iron?

Mr. BESSEMER: We get a very pure charcoal iron for that purpose, and the amount of other matters or impurities present, except manganese, is so small as practically not to interfere with the purity of the metal.

Captain JASPER SELWYN, R.N.: I am sure Mr. Bessemer will excuse another member of the Institution asking a question. We have many inquiring minds, and as the results affect us most materially, I think I may beg his indulgence for a moment. I do not think we have quite arrived at a conclusion as to what the relative cost of steel thus prepared is to the cost of ordinary steel. It would be most useful if we had some accurate comparison. So many different opinions are entertained upon the point, so many different statements have been made—I will not say by parties interested, but by parties who have not quite interested themselves enough in the subject—that it is very desirable that any fallacies existing on the subject should be settled at once, by reference to the source from which we can alone get correct information. I do not speak of the comparative cost of making the steel under the system of licences, which I hope may long continue to yield profit to Mr. Bessemer, but of the way in which it could be made with the view to large operations by the Government. That I think would be a most valuable point to make clear. I think gentlemen will join with me in admiring the splendid illustration which this lecture has conveyed to us of the value of scientific research. Mr. Bessemer would in vain have sought for the conclusions which have led him to such successful results, had he not had the labours of chemists in their studies for centuries past, to give him the constituent parts of the matters with which he has to deal. Therefore, let us never undervalue the labours of the old man who bends his withered frame over a furnace, it may be in search of the philosopher's stone, but who yet gives many results to the world, which, centuries after his death, become of the utmost value to mankind.

Mr. BESSEMER: As regards the cost of production of this metal, it will be interesting perhaps to you to know, that at the time when Colonel Wilmot was in power at Woolwich, just before Sir William Armstrong went there, I had interested him very much in this manufacture. Indeed I should rather say his own intelligence had so pointed out to him that something was to be done more than could be done by the old mode, that he rather sought me out. He expressed himself very much delighted with the prospect which my process seemed to offer of giving a better description of ordnance at Woolwich than they had before. They had not been so successful in cast-iron guns as they had hoped to be, and Colonel Wilmot was most desirous that their valuable foundry should be turned to the greatest possible account by the Government. On more than one occasion he said to me, "We have the space, we have the buildings, we have the furnaces, and we have the casting pits and the moulds; but the cast-iron we pour into them is not good enough for a gun. Why should we not first blow that metal with a little air, and then put it into our moulds, and then we should have a superior material." So strongly was he

imbued with that idea, that after visiting my works at Sheffield, he communicated to the authorities at Woolwich what he had seen; and on more than one occasion I had interviews with him on the subject. Indeed, I went so far as to give a written contract to the late Lord Herbert, who was then at the head of affairs at Woolwich. In that contract I undertook for £5,000 to erect enough machinery on my principle to produce two hundred tons per week of cast steel blocks for the Government, and my estimate was that cast steel blocks poured into their own moulds would cost £7 per ton.* Lord Herbert said he would refer the question to Sir William Armstrong, and I never heard anything more about it. With regard to armour-plates, as far as my opinion goes, Bessemer steel is totally unfitted for the purpose. It is very well to say "there is nothing like leather," but sometimes leather is not good. I believe that in the condition of steel we shall never produce an armour-plate that will stand even cast-iron shot. I believe that an armour-plate requires to be exceedingly soft and tough, and not hard like steel. In fact, the general characteristics of steel wholly unfit it for armour-plates. I believe also that a considerable improvement in armour-plates may be made by in part carrying out my process of steel making; that is, if we reduce cast-iron to the state of very soft pure malleable iron, and do not recarbonise it, we shall then have a metal the toughness of which is almost beyond belief. Indeed, excepting the very best copper, I do not know any metal that is equal to it in toughness, and its softness approaches so near to copper, that it may fairly be taken out of the category of common iron. I believe that that metal may be made into armour-plates with great advantage. But in order to get that excessive toughness which you require in the armour-plates, if you cast a large mass a granular structure will run through it, but if you roll it into thin plates and weld them together, the structure will be much changed, and we shall then have separate layers of toughened metal. If we take a large granular mass of steel and compress it from one foot square to six inches square, we shall find the structure altered very little indeed. But if you bring it into a much smaller space, it appears that the crystals get elongated, and that their cohesion is very much increased. Now I think that that increased strength and toughness can be best got by reducing the metal to small sections; but I think the ordinary mode of welding renders it so exceedingly imperfect that we should try and improve in that direction; and it is in that direction I am attempting to go. Every one who has seen the experiments on armour-plates will have observed that when the shot strikes a plate and penetrates to a certain extent, large masses generally fly off from the back. When these large masses tear off we always get a large portion of the surface separated in the direction of the weld of the plate, but if welding ever took place thoroughly, that separation would never take place.

Admiral HALSTED: It never has been done.

Mr. BESSEMER: It never has been done, and never can be, on the system by which welding is now attempted. The mode by which I think welding may be effected is this. Having rolled a certain number of plates, I would put them in diluted acid in the same way that you prepare plates for tinning, or galvanising, by which means the thick coat of oxide which they acquire in rolling is separated from the metal. We have then a clean surface of metal to act upon. When they are taken out of this pickle-bath, I would put upon them a sort of wash, that is, any easy melting flux, silica being one of the constituents. If you then put a number of plates so coated together, and get up a welding heat upon them, a good weld may be made, for there is no oxidised surface to begin with, and the surface is so coated and protected from the contact of atmospheric air that they acquire no new coat of oxide while being heated up. Again, we have between all these surfaces (by the time the welding heat is arrived at) a perfectly fluid matter, which under the pressure of the rolls will come out from between these surfaces; and as in the act of soldering, you allow metal to come in contact with metal, and a much more perfect union takes place than is possible when there is a hard dry scale of oxide between the surfaces of the several plates. How far this may produce an absolute junction of the metals

* This was in 1859, when the pig iron employed was nearly £2 per ton cheaper than at present.—H.B.

it is difficult to say; but I think it will produce it much more effectually than at present.

The CHAIRMAN: Just on the same principle that borax is used for soldering.

Mr. BESSEMER: Exactly.

Mr. BARRASS: Is it possible to cast a gun with a core?

Mr. BESSEMER: As far as my experience goes the casting of steel with a core is an exceedingly difficult matter. There are very few materials known to us that will stand the excessive heat of melted steel without going into a state of fusion Ordinary sand fuses rapidly in the presence of steel in a melted state; and whenever the core commences to fuse on its surface, the gases generated can never pass out through the pores of the mould, but they pass into the metal, which becomes imperfect.

Captain SCOTT, R.N.: Will you allow me to ask what is the size of the guns that the Prussians have ordered?

Mr. BESSEMER: I am not at all aware.

Mr. D. LONGSDON: Perhaps I may be allowed to supply that information, being the brother of Mr. Krupp's agent in this country. The guns ordered of Mr. Krupp by the Prussian Goverment have been 7, 9, and 11 inch.

A MEMBER: Will the gentleman allow me to ask whether they are cast solid, or hollow?

Mr. LONGSDON: Solid, afterwards hammered, and then bored.

A MEMBER: We hear that the Americans cast guns of heavy calibre with a core, and in order to avoid what Mr. Bessemer mentioned, the melting of the core, they have an ingenious plan of allowing water to percolate through to keep it in a cool state. If that can be done, I wish to ask Mr. Bessemer whether he thinks it would be desirable?

Mr. BESSEMER: I think that the amount of forging which is necessary on a piece of cast-steel to develope its full strength is such, that it would be impossible in a gun cast with a core, to give it the amount of working that is necessary to develope its proper strength. The forging of a hollow gun would be very unsatisfactory in the interior; we could not introduce the mandril into it; for, if it closed upon it, the mandril could not be got out again.

Captain SCOTT: I can supply some information that may complete this paper. You have mentioned about steel for guns. There are steel guns in the Arsenal which were supplied by Krupp. There is a 110-pounder, a 40-pounder, a 25-pounder of his, and there is also a gun supplied by Naylor Vickers. The whole of these guns went through the one hundred rounds with increasing cylinders, and were found to be perfect afterwards, with not a single crack to be seen in them. The 25-pounder of Krupp, and the 25-pounder of Vickers were then fired with double charges. They are still uninjured, and may be seen by anybody who wishes to look at them. No other guns have ever stood such a proof before. All the coil guns that have been similarly tested have been more or less injured.

Admiral HALSTED: To what size have you yet produced your ingots?

Mr. BESSEMER: At our own works we have only produced ingots up to six tons in weight.

Admiral HALSTED: What diameter would that be?

Mr. BESSEMER: That would make one of our largest ship guns, I suppose, about five tons when finished. We are making apparatus, however, for one firm that will produce masses twenty tons in weight: indeed we should have no difficulty in producing fifty tons.

Mr. ASTON: Will they put down steam hammers in proportion?

Mr. BESSEMER: Certainly.

Mr. ASTON: I believe Mr. Krupp is using steam hammers of one hundred tons.

Mr. BESSEMER: He is using very large ones; I do not know the weight.

Mr. ASTON: He has had several of fifty tons.

Mr. LONGSDON: The largest steam hammer that Mr. Krupp is using is fifty tons, with a fall of 10 feet. He is now putting down to assist that hammer, which has so much to do in consequence of recent orders, two hammers of thirty tons each.

LECTURE.

Friday, May 13th, 1864.

GENERAL H.R.H. THE PRINCE OF WALES, K.G., K.S.I., &c., &c., Vice-Patron of the Institution, in the Chair.

RAILWAYS STRATEGICALLY CONSIDERED.

By Captain H. W. TYLER, R.E., Railway Department, Board of Trade.

AN eminent soldier and author of the last century—Marshal Saxe—asserted that legs were of more value than arms in war. Other writers express the same idea in saying that the whole secret of war consists in marching; and the Archduke Charles proves the truth of it by showing that certain battles are won by successful strategy before they are fought. Now strategy is simply the art of moving military forces to the best advantage on a theatre of war; and the objects to be attained in the practice of it during a campaign (as well as in the practice of tactics during a battle) are (1) to be superior at the proper time and at the decisive point, and (2) to threaten the communications of an enemy without exposing your own. Setting political considerations aside, war is from beginning to end a question of communications. The Romans, when they subjugated a country, set to work at once to make roads through it, and those roads remain to the present day. In now forming the plan of a campaign, the main points to be considered are the direction in which and the lines by which the forces shall be moved. In carrying it out, the principal care of a commander is to prepare for victory by employing the means of communication or transport at his disposal to the best advantage, and massing his forces on the decisive points. The position of those so-called decisive points depends upon the communications of the country. The nature of ground, the position of rivers, mountains, marshes, is chiefly important as affecting the progress of the troops, and the way in which their communications can be secured. The manœuvring which sometimes precedes an engagement is effected with a view, either to cut off a portion of the enemy before the remainder can come up, or to obtain a position from which his communications may be threatened; and a mere threat of this sort is frequently sufficient to force an enemy to retreat without fighting. During a battle, on a scale of whatever magnitude, the victor looks mainly to the communications of his enemy, the vanquished to his own. And in the course of a pursuit, the object of the victor is still to intercept his

foe's communications, and thus to cut him off from his base of operations.

Communications being thus, as it were, of supreme importance in warfare, and the success of campaigns depending mainly upon their being used to the greatest advantage, it is a matter of the highest interest to all military students to study the effect of railways upon the various operations of war, and to profit, as far as possible, by the experience which has been afforded in other countries on the subject.

It is not yet forty years since passenger railways came into use, and there were at the end of last year 12,299 miles of railway open for traffic in this country alone,—in which 400 miles a-year are still being constructed. In round numbers there are about 113,600 miles of railway in the world, of which 53,000 are in Europe, 52,000 are in North America, 6,000 (principally in British India) are in Asia, 1,800 are in South America, 600 are in Africa, and 200 are in Australia. They will no doubt continue to increase for a length of time with great rapidity; and the more they spread over a country, the more important they become in a military sense. The tendency of railways in every country is to radiate from certain centres of traffic and commerce. The trunk lines are first filled in, then secondary lines and cross lines, and, finally, the means of communication between, first, the principal, and, secondly, the inferior places become multiplied. It is impossible now to lay out any long line of railway in this country which does not compete more or less with existing lines. The junctions at which some of these lines meet must become strategic points of the greatest importance to the defence of every country—points on which an invader would at once seize, and the loss of which would very much hamper the operations of the defenders. Looking at the map of England, such points are at once apparent. An enemy landing on the south coast would naturally regard the junctions at Brighton and Lewes, of the line from London with the South Coast Railway, as points of primary importance, and Canterbury, Ashford, and Hastings on the one side of it, as well as Havant (on the north of Portsmouth) and Bishopstoke (on the north of Southampton) on the other, are also places of great importance for the same reason, namely, that the main lines out of London join the coast lines at those points.

Of these junctions, Canterbury and Ashford derive protection from the fortified position of Dover, and Havant and Bishopstoke from that of Portsmouth; and it is evidently not necessary, under existing circumstances, to throw up works in anticipation for the defence of the remainder, as it might be if our coasts were more accessible, our fleets less strong, and our volunteers less efficient. But with our *vital points* placed, as they are (except Spithead, the most important of them all), in a respectable position of defence, and with 150,000 gallant volunteers ready to assist the regular forces in manning our forts, as well as in more active operations, we need be under no apprehension for the safety of the country. I would, however, while on this subject, say a few words in regard to the defence of our coasts. There is a very general opinion—and confirmation has been prominently given to it by a gallant naval officer in this theatre—that our

system of coast railways might, if the connection were completed at certain points, be relied upon for conveying troops to prevent the landing of any hostile force. I need hardly say that any invasion of this country would be attempted in great force, and that the portion of the coast which would require to be specially guarded lies between Portsmouth and the Thames. The enemy might be expected in several divisions, and at different points, and our great object would be to have four or five thousand men (including a strong force of artillery) *on the spot*, ready to fire into their boats as they approached the shore, supported by the fire of their larger vessels. If they were to land unopposed, or inadequately opposed, then we should have lost the best opportunity for attacking them at the most critical period of their first operation,—as they were approaching the shore, leaving the boats, and forming on the beach. Now the coast railway cannot follow all the sinuosities of the coast, and is in places several miles from it; and during the time that would be occupied by a body of troops in marching (on being warned by telegraph) to the railway, in embarking upon it in successive trains, in performing their railway journey, in disembarking from the trains, and in marching to the spot at which a feint had been made, or at which their presence was really required,—these operations having taken all the longer for want, perhaps, of platform and siding accommodation at the particular points of the railway employed,—the enemy would have reached the shore, and would have taken up a position in force to cover the landing of more troops.

In this, as in all other cases, railways are comparatively of little use for short distances, or where troops have to march any great distances to and from them. The length of time occupied in preparing the trains and embarking the troops (including cavalry and artillery) is considerable as compared with that consumed on the journey. On the other hand, 20 or 30 extra miles in a railway journey, when the troops are once embarked, is only a question of an hour's travelling. It is obviously in the case of long journeys, in which the troops can perform in an hour, and without fatigue, what would otherwise be a hard day's march, that they are of most service.

If we were obliged to make serious preparations against an invasion, we should do well, for these reasons, not to rely upon coast railways alone, but to form camps in the necessary localities round the coast, and to organize movable brigades,* able to move independently of the railways, or to take advantage of them, as might be required.

In considering the relative importance of roads, rivers, and railways, we must reduce them to the common measure of time. In military operations, victory is a question of days, or hours, or sometimes even of minutes, in the movement of troops, when the forces are on anything like an equality. The time that will be required to march a certain number of troops to a given spot having been calculated, and their support being a matter of vital importance to the contemplated

* Such, for instance, as that which was so efficiently equipped and instructed at Shorncliffe in 1804, under (Sir John) Moore, and which afterwards became so celebrated as part of the Light Division in the Peninsula War.

operations, delay may ensure defeat, as punctuality may render success comparatively certain. Those were anxious moments during which Blucher was floundering through the mud with his gallant troops on his way towards the field of Waterloo. But the computation must be separately made for each road, each railway, or each river, according to their respective qualities and means of accommodation, and that irrespective of distance. So many hours, rather than so many miles, from A to B—from any one point to any other point on the chart—with such and such chances of obstruction, impediment, or delay, is the result at which any one arranging the plan of a campaign wishes to arrive, and on which he must base all his projects.

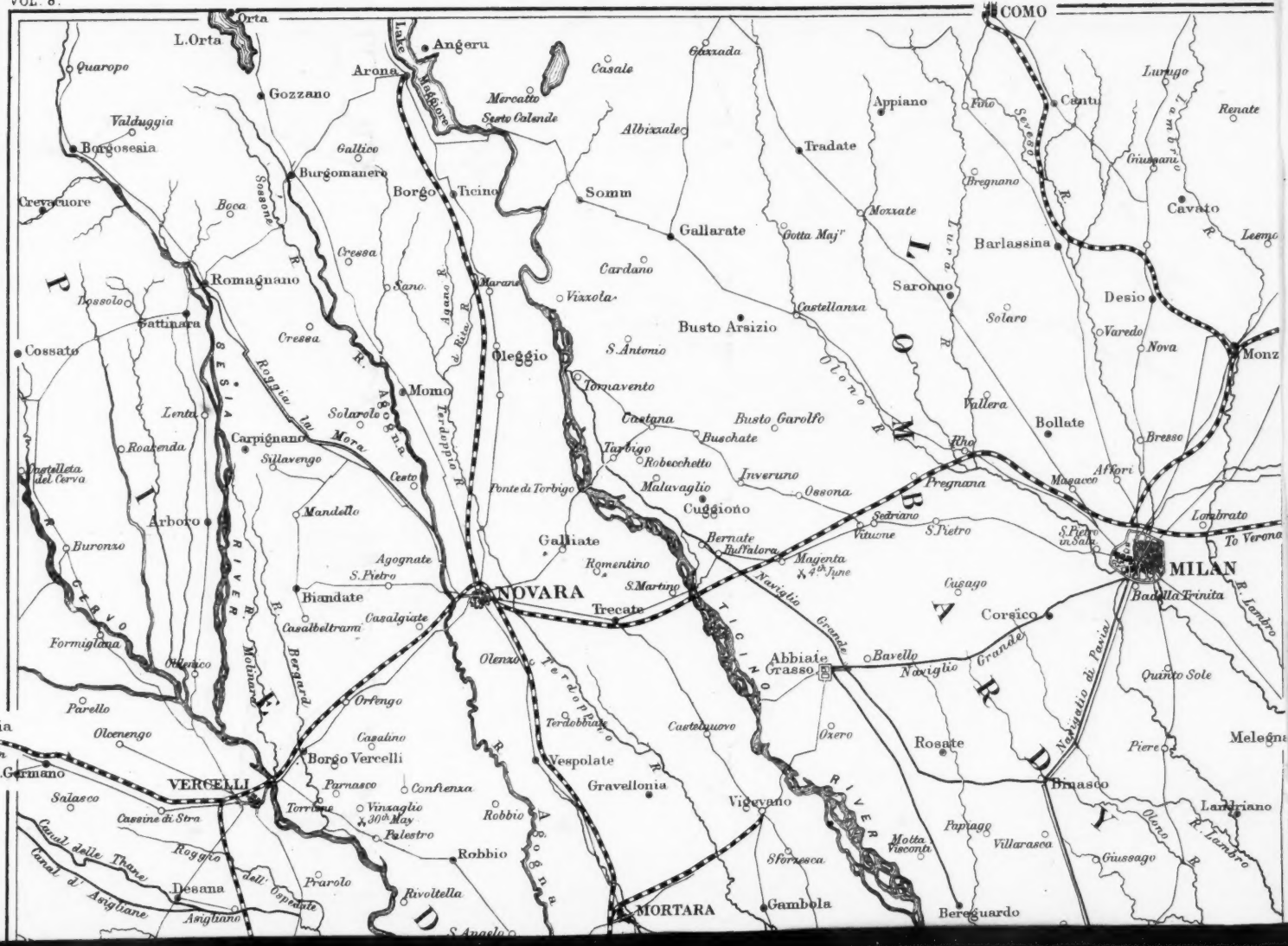
On a well made railway, in good order, with two lines of rails, the number of troops that can be despatched with their stores and ammunition, is only limited by the number of vehicles available, and the delay in forming, loading, and despatching the trains at one point, and unloading and returning them from the other. There are about 7 locomotive engines, 21 carriages, and 140 trucks or waggons, for every 10 miles of railway on the principal metropolitan lines of this country. But the rolling stock of any one line may be employed upon any other line, as is frequently done for purposes of excursion traffic, when the guage is the same. In the event, therefore, of hostile invasion, or in any case in which a partial interruption of the ordinary traffic would be temporarily justifiable, the supply of locomotive power, and of vehicles for the transport of men, horses, guns, and ammunition, would be practically unlimited.

A field battery of artillery will take 45 minutes to load, and 45 minutes to unload, and will require, on the narrow guage lines of this country, six carriages, 20 trucks and break-vans, and 57 horse-boxes, making altogether 83 vehicles. These might be conveyed along a tolerably level line in two trains, weighing, besides the engines and tenders, about 250 tons each. A regiment of infantry,* requiring 40 vehicles, might in like manner be taken in one train. And a regiment of cavalry (at 400 horses and 500 men) with baggage and forage, requiring 135 horse-boxes, and 25 other vehicles, might be taken in four trains. When loading banks are not available, or are insufficient, temporary platforms are required for embarking horses and guns, and the time which would be occupied depends upon the amount of accommodation provided.

An army division consisting of two brigades, of two regiments of infantry, one of cavalry, and one field battery each, would thus be conveyed in 16 trains, each composed of about 40 vehicles; and an army corps containing three such divisions would travel in 48 trains of similar dimensions.

In connection with this subject, it may be interesting to mention what was done on the Brighton railway in 1863, in conveying the Volunteers to the Review near Brighton on Easter Monday. I happen to have the details by me, as I had occasion to obtain them at that

* Soldiers occupy more space in railway carriages than ordinary passengers of the same class, in consequence of their arms and accoutrements.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Orta
L. Orta
Lake Maggiore
Angera
Arona
Quarone
Gozzano
Valduggia
Borgosesia
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Gallico
Burgomanero
Borgo Ticino
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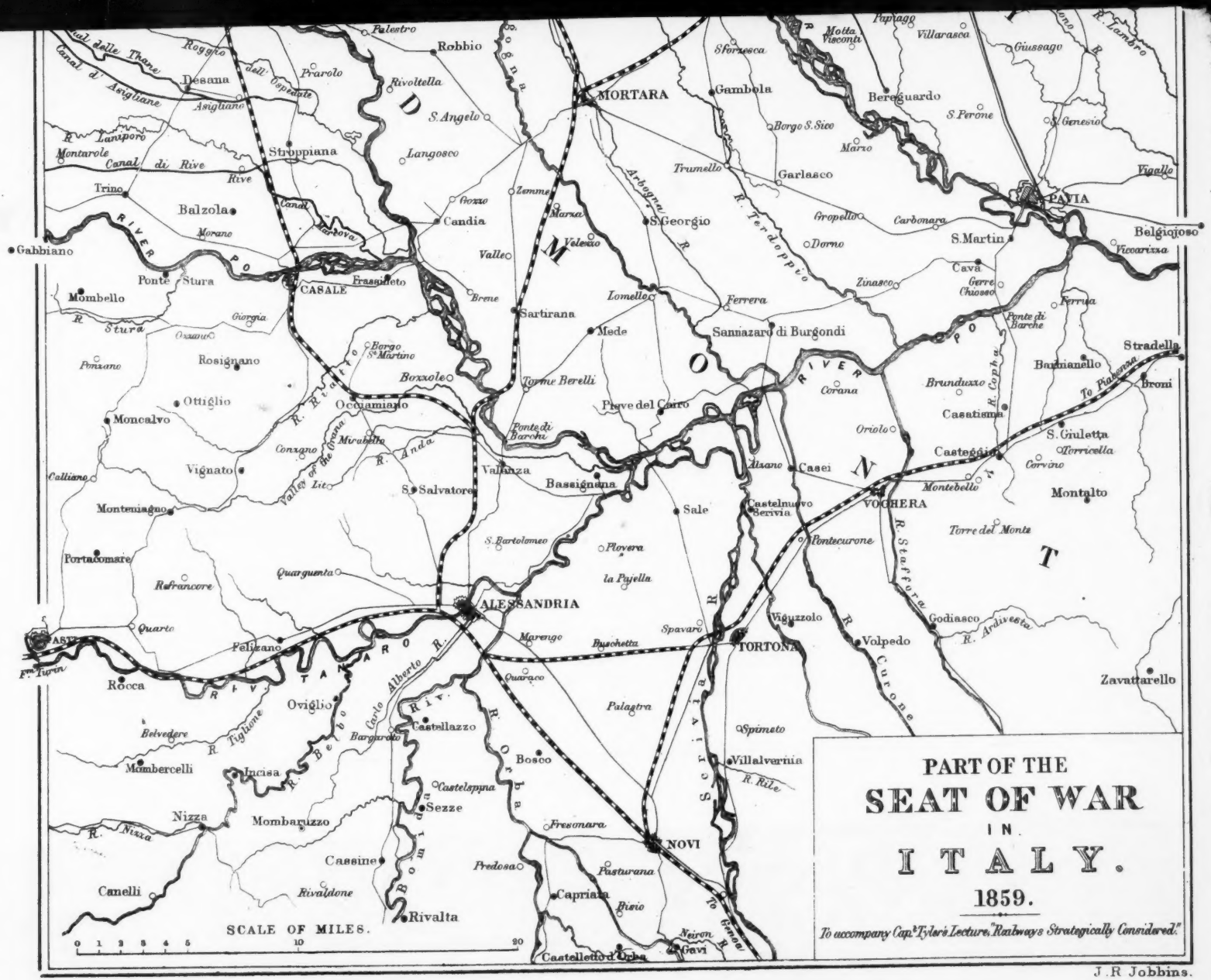
Casale
Mercatto Sesto Calende
Albizzate
Gazzada
Tradate
Appiano
Fino
Centu
Lurago
Renate
Cavato
Barlassina
Lesmo
Bregnano
Mozzate
Gallarate
Gotta Maj.
Cardano
Vizzola
Castellanza
Busto Arsizio
Saronno
Solaro
Desio
Varedo
Nova
Monz
Romagnano
Sesia R.
Sesone R.
Agogna R.
Rile R.
Tenore R.
Olona R.
Lura R.
Seveso R.
Lambro R.
Cressa
Sano
Marano
Oleggio
S. Antonio
Tornavento
Momo
Cressa
Roggia Mora
Agogna R.
Torbido R.
Lenta
Solarolo
Carpignano
Sillavengo
Cesto
Castana
Busto Garolfo
Buschate
Tarbigo
Robecchetto
Inveruno
Malvaglio
Ponte di Torbigo
Cuggiono
Ossona
Pregnana
Vallera
Bollate
Rho
Bresso
Affori
Mosacco
Lambrate
To Verona
Cossato
Rossolo
Gattinara
Roasenda
Castelletta del Cerro
Arboro
Buronzo
Mandello
Galliate
Bernate
Buffalora
Magenta
4th June
Vittuone
Sedriano
S. Pietro
S. Pietro in Sala
MILAN
Badilla Trinita
Agognate
S. Pietro
Romentino
S. Martino
NOVARA
Trecate
Naviglio Grande
Cusago
Corsico
Biandate
Casalbeltrame
Casalgiate
Formigiana
Olcenico
Parello
Orfengo
Olenzo
Terdobbiate
Castelnuovo
Oxero
Abbiate Grasso
Bavello
Naviglio Grande
Quinto Sole
Naviglio di Pavia
Santhia
from Turin
Olcenengo
Casalino
Borgo Vercelli
Vespolate
Rosate
Piere
Melegna
S. Germano
VERCELLI
Parnasco
Confienza
Gravellonia
Vigevano
Binasco
Landriano
Salasco
Cassine di Stra
Torrione
Vinzaglio
30th May
Palestro
Robbio
Papiago
Villarasca
Olano R.
Lambro R.
Canal delle Thane
Canal d' Asigliane
Roggia dell' Ospedale
Desana
Prarolo
Rivoltella
Asigliano
Sforzesca
Motta Visconti
Giussago
MORTARA
Gambola
Bereguardo
S. Angelo
LOMBARDY
PIEMONT


PART OF THE
SEAT OF WAR
IN
ITALY.
1859.
To accompany Capt.n Tyler's Lecture, "Railways Strategically Considered."
SCALE OF MILES.
0 1 2 3 4 5 10 20
MORTARA
PAVIA
ALESSANDRIA
VOGHERA
TORTONA
NOVI
CASALE
CASTE
Robbio
Palestro
Desana
Asigliano
Prarolo
Rivoltella
S. Angelo
Langosco
Stroppiana
Trino
Balzola
Morano
Gabbiano
Mombello
Ponte Stura
Giorgia
Pontesano
Rosignano
Ottiglio
Moncalvo
Vignato
Calliano
Montemagno
Portacomaro
Refrancore
Quarto
Felizano
Rocca
Oviglio
Belvedere
Mombercelli
Incisa
Nizza
Canelli
Cassine
Rivalta
Sezze
Castelspina
Bosco
Castellazzo
Bargardo
Mombaruzzo
Predosa
Rivaldone
Capriata
Pasturana
Fresonara
Castelletto d'Orba
Gavi
Neiron R.
Villalvernia
Spinato
Palastra
Quaraco
Marengo
Buschetta
Spavara
Vigazzolo
Volpedo
Godiasco
Zavattarello
Torre del Monte
Montalto
Montebello
Castelnuovo Scrivia
Pontecurone
Sale
Plovera
la Pajella
S. Bartolomeo
Valenza
Bassignana
S. Salvatore
Occimiano
Borgo S. Martino
Boxxole
Torre Berelli
Pieve del Carro
Ponte di Barche
Sartirana
Mede
Lomello
Ferrera
Sannazaro di Burgondi
Zinasco
Cava
Gerre Chiosso
Ferrera
Ponte di Barche
Corana
Brunduxxo
Casatisma
Oriolo
Casteggio
Corvino
Torricella
S. Giuletta
Broni
Stradella
Barbianello
To Piacenza
Vigevano
Carbonara
Gropello
Dorno
S. Martin
Belgiojoso
Vicovarixxa
Garlasco
Trumello
Borgo S. Sico
Marzo
Bereguardo
S. Perone
S. Genesio
Gambola
Motta Visconti
Sforzesca
Papiago
Villarasca
Giussago
Lambro R.
Vigello
Zemme
Gozzo
Candia
Marza
Velezzo
Valle
Brene
Arbogna R.
Terdoppio R.
Scrivia R.
Curone R.
Staffora R.
Coppa R.
Ardivesta R.
Rile R.
Orba R.
Tanaro R.
Tiglione R.
Belbo R.
Nizza R.
Bormida R.
Corlo Alberto R.
Lanzoro R.
Montarole
Canal di Rive
Rive
Canal
Canal delle Thane
Roggia dell' Ospedale
Canal d' Asigliane
Asigliano
Morano
Ponte Stura
Frassineto
Occimiano
Mirabella
Conzano
Valley of the Grana
Valley of the Lita
R. Anda
R. Ricotto
R. Stura
R. Lanzoro
Fm. Turra
Quarguenta
Pontecurone
Castelnuovo Scrivia
Servia
Casei
Lisano
Oriolo
Corana
Ponte di Barche
Ferrera
Zinasco
Cava
Gerre Chiosso
Dorno
Gropello
Carbonara
S. Martin
Belgiojoso
Vicovarixxa
Garlasco
Trumello
Borgo S. Sico
Marzo
Bereguardo
S. Perone
S. Genesio
Gambola
Motta Visconti
Sforzesca
Papiago
Villarasca
Giussago
Lambro R.
Vigello
Zemme
Gozzo
Candia
Marza
Velezzo
Valle
Brene
Arbogna R.
Terdoppio R.
Scrivia R.
Curone R.
Staffora R.
Coppa R.
Ardivesta R.
Rile R.
Orba R.
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Roggia dell' Ospedale
Canal d' Asigliane
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Morano
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Bormida R.
Corlo Alberto R.
Lanzoro R.

J. R Jobbins.

time for another purpose. The system of that railway comprised 240 miles, and the Company possessed 145 locomotive engines, 1,858 carriages or passenger vehicles, and 2,588 waggons and trucks, or merchandize vehicles. On the morning of the review, 6,922 volunteers were despatched from the London Bridge station in 9 trains in 2 hours and 41 minutes, and 5,170 volunteers from the Victoria Station in 7 trains in 2 hours and 20 minutes, without difficulty. They travelled to Brighton, 53 miles, in 2 hours and 28 minutes, on an average from the time of starting. The railway company had to provide also on that day for Easter Monday traffic to the Crystal Palace, for all their ordinary traffic, and for 2,000 volunteers along the South Coast from stations on their own line. They carried altogether on that day 132,202 passengers, including volunteers and the holders of season and return tickets. To meet this extraordinary traffic, they borrowed 72 carriages from three neighbouring companies, and 79 carriages brought volunteers to and over their railway from other lines.

I would now refer to some of the leading features of the Italian campaign of 1859, of which so good an account has already been furnished by Major Miller in this theatre. I have marked in black on the excellent map of Lombardo-Venetia which hangs on the wall, the railways that enclose, and in blue some of the rivers that intersect, the country* in which the principal part of that campaign was fought. The railway bridges over the principal rivers, and especially that over the Po at Casale, which was included in the fortifications at that place, were naturally points of importance. The Austrians possessed, as will be seen, lines of communication by railway from Verona, which was their principal base of operations, to the north by the valley of the Adige—to Venice and Udine on the east—to Mantua on the south—and to Milan, Novara, and Vercelli on the west. The Allies, on the other hand, whose base was at Alessandria, had the advantage of railways to Genoa on the south and Turin on the west; and there were railways also to Vercelli and Mortara on the north, and towards Piacenza on the east.

Some of the French troops travelled from Paris to Lyons by railway, 25,000 in a day. Some moved from Paris to Genoa in five days. 12,000 men are said to have left Paris for Lyons on the night of the 21st of April. A battalion of one regiment went from Lille, through Paris and Lyons, to Marseilles, including the passage through Paris and three hours of detention at Lyons, in 40 hours. The Austrians also sent a fourth corps d'armée by railway from Vienna; and an accident occurred at an early stage of the proceedings, which shows how desirable it is to use separate trains for troops and gunpowder. Nearly 150 Austrian soldiers were killed and wounded in an accident on the Verona railway, during which some of the ammunition waggons exploded.

During their advance into Sardinia and their occupation of the line of the Dora Baltea, the Austrians tore up the rails and destroyed the

* See Plate xxvi.

railway bridges which they met with; but this did not cause any serious impediment to the Allies, because the damage was repaired sufficiently to allow of their being again used as soon as they were required. On the 6th they blew up the railway bridge at Pontecurone, near Voghera; on the 7th that at Valenza; and on the 19th the arches of that over the Sesia, near Vercelli. But the Valenza bridge was afterwards made good by an earthen embankment in place of the two arches that were destroyed, and a Sardinian battery was established, with gabions, fascines, and earthworks, at the west end of it.

The Chasseurs de Vincennes, brought into Turin by successive railway trains, are described as having issued from the station, not fagged and reduced in numbers, as they would have been after a long march; but first at the "pas de charge," and afterwards at a run, with their knapsacks, capotes, tents and poles, batteries de cuisine, &c., &c., on their shoulders; amid shouting, and trumpeting, and clapping of hands; and it is added that "flowers were thrown down from the balconies upon these brisk soldiers as they passed through the streets." How different from the defenders of Sebastopol, who, from want of railway communication, lost the greater part of their numbers in crossing the steppes on their route to the scene of the conflict!

Between the 19th and 28th May the Austrians occupied a defensive position, not connected by means of railways, extending for about 50 miles along the Sesia and the Po, from Vercelli to Pavia; while the French and the Sardinians, with their principal force at the fortress of Alessandria, were on the line, 30 miles long, from Casale to Valenza and Voghera, on the opposite side of the Po, with the advantage of railway communication, not only from one extremity to the other of that position, but also, in continuation, to Vercelli, Novara, and Milan, on the one side, and to Piacenza on the other. And Milan was the first point which it was the object of the Allies to reach.

The Austrian general, unable to divine that object, and anticipating an attack on his left rather than on his right, removed his head-quarters from the more advantageous position of Mortara to Garlasco, nearer to Pavia, on the 19th May; and on the 20th the reconnaissance was made under his instructions which led to the battle of Montebello.

Count Stadion was directed to attack Casteggio and Montebello about noon, and having taken those places, to use them as a basis for threatening Voghera, and thus to oblige the enemy to display his his strength. He accordingly crossed the Po at Viccarizza, and joining Urban from Stradella, advanced, partly along the railway, and partly by different roads, with 20,000 men towards Voghera. He carried the heights about Casteggio, and pushed on to Genestrello; but Count Gyulai says in his despatch, "The enemy, however, soon displayed a superior force, which was continually increased *by arrivals by the railway*, so that Lieutenant Field-Marshal Urban's and Gaul's brigades, which had come up to his assistance, were compelled, after great loss, but heroic fighting, to fall back on Montebello."

The special correspondent of the *Times*, writing from Pavia on the 21st May, says: "From the heights of Montebello the Austrians

beheld a novelty in the art of war. Train after train arrived by railway from Voghera, each train disgorging its hundreds of armed men, and immediately hastening back for more. In vain Count Stadion endeavoured to crush the force before him before it could be increased enough to overpower him." It is to be observed also that the 74th, 91st, and 98th Regiments were, as stated in General Forey's despatch, dated midnight on the 20th May, employed in defending the railway at Cascina Nuova against the Austrians under Brauen, who advanced along the railway to attack it.

The Austrians retreated, in the words of the Austrian bulletin published in the *Wiener Zeitung*, after the enemy had been obliged to develope his whole force; and they thus claimed to have effected the object they had in view. But what Count Stadion really did, under the orders of Count Gyulai, was this: he advanced towards and partly along a line of railway which was directly connected with the principal base and head-quarters of the allied forces only twenty-five miles from Voghera. With 20,000 men under his command, he was, of course, able at first to push back the advanced posts of the enemy; but in threatening Voghera, and in giving time for a further display of hostile force, he only waited for reinforcements to arrive by that railway. Further delay on his part would have increased the number of his opponents to any amount necessary for defeating him, and it was only by retreating when he did that he avoided a serious disaster.

He discovered, it is true, that there was no great number of the allies in the neighbourhood of Casteggio, but he found out, also, what he does not appear to have anticipated, any more than Count Gyulai, that the railway afforded means for bringing up fresh troops. In reality, a reconnaisance in that particular direction appears hardly to have been required, because the allies could not have advanced towards the strong fortress of Piacenza, or have attempted to cross the Po between Piacenza and Voghera, with any immediate prospect of success.

Between the 25th of May and the 2nd June, and while, therefore, the above battles were being fought, that flank movement was effected by the French which was destined to be the leading feature and the turning point of the campaign.

The Sardinians were concentrated at Vercelli on the 29th May, were fighting at Palestro and Confienza on the 31st May, and moved to the Agogna on the 2nd June.

The third French corps moved from Ponte Curone to Casale, miles, on the 28th May, to Prarolo on the 29th, constructed a bridge there over the Sesia on the 30th, crossed to Palestro in support of the Sardinians on the 31st, and was at Robbio on the 2nd June.

The second corps marched to Casale on the 29th and 30th, reached Vercelli on the 31st, and Novara and Olenzo on the 1st June.

The fourth corps proceeded to Casale on the 29th May, to Borgo Vercelli on the 30th, and to Novara and Olenzo on the 1st June.

The Imperial Guard proceeded to Casale and Vercelli on the 29th and 30th May, crossed the Sesia on the 1st June, and reached Novara and Turbigo on the 2nd June.

The first corps remained at Voghera till the 1st June, to deceive the Austrians, and moved nearly 60 miles from Voghera to Vercelli on that day.

This was undoubtedly a bold and hazardous movement, and one which might have been attended with fatal results, if undertaken in the face of a more active enemy, possessed of better information.

The first corps remained isolated at Voghera, 25 miles from Alessandria, and 50 or 60 miles from the other corps of the allied armies at Vercelli and Robbio. It is true that they were, with the assistance of the railway, only one day's journey from the rest of the army; but the Austrians might, without serious difficulty, have made arrangements for arresting their progress at almost any part of their journey on the 1st June; or they might have cut them off from their communications and annihilated them on either the 30th or the 31st May.

The third corps at Prarolo on the 29th May, and at Robbio on the 2nd June, afforded protection, in conjunction with the Sardinians, from an attack towards Vercelli, as long as the Austrians were inferior in numbers in that direction; but no such protection was provided near Valenza, where the railway is nearest to the river Po, and was most liable to attack. The third and fifteenth Austrian corps were near this important point when the flank movement began on the 28th May, but were afterwards ordered to march northwards. Indeed there was no time during the four days, from the 29th May to the 1st of June, and hardly any point betweeen Vercelli and Voghera, at which the Austrians might not, by better dispositions and rapid movements, have struck such a blow at the French as would have changed the face of the campaign, and perhaps even the issue of the war. They heard the engines and trains at work on the railway between Casale and Vercelli on the night of the 31st May, and they saw French troops on the march from Vercelli to Novara on the following morning, and Zobel requested to be allowed to attack them. But it was only on the 2nd of June, apparently, that Gyulai found out that he had been circumvented, and made up his mind materially to alter the disposition of his troops. He then directed the six corps which lay between the Ticino and the Sesia to retire to the left bank of the Ticino, and the two corps at Pavia and Piacenza to move northward, about the same time that Count Clam, with the first corps, which had been hurried up from Bohemia by railway in an incomplete state, was approaching the Ticino from Verona, also a day too late.

The allies were by this time in an excellent position for moving on Milan. Concentrated in the neighbourhood of Novara, they had only the river Ticino, and the grand canal, guarded by one incomplete corps, before them, while the mass of the Austrian army was further than that of the allied army from the critical point. Their sudden and rapid movement to the north was thus justified so far by success, as rash operations frequently are; but it does not afford an example which should be frequently followed. A flank movement before an active and powerful enemy is always dangerous, because the troops engaged in it are necessarily ill prepared for attack, and are liable to

become engaged at particular points with superior forces. But such a movement in railway trains without adequate support is particularly so. The same precautions cannot be taken as on the march against a sudden attack, a surprise, or an ambuscade. Scattered in different trains along a line of railway, even the infantry, and more especially the cavalry and artillery, cannot readily be disembarked and brought into line-of-battle, and are, for the time, almost without power of resistance.

An obstruction suddenly caused on a railway during the transport of troops, either by the destruction of a bridge, or the displacement of a few rails, as the work of an enemy, or else by the bursting of a locomotive boiler, or a train running off the line, or any other so-called accident, may cause delay for hours or even days, and may be the means, by dividing an army into two or more parts, of exposing it to the risk of being beaten in detail.

These contingencies must never be lost sight of, or left unprovided for, in employing railways for strategic purposes.

The Austrian position on the Po and the Sesia was a good one in the first instance, either for opposing an attempt to cross the Po in the direction of Piacenza, or for striking at the allies during such a movement as actually took place towards Novara. But the only important move which they made from it towards Voghera was a false one; they were otherwise too inactive; and they retained it too long. Either they were too late, or their arrangements were hurried and imperfect at all points, after the battle of Montebello; and this happened principally from want of early and correct information, which, being essential to the success of all military operations, a first-rate commander, acting wisely, always takes measures to obtain. The whole country was no doubt hostile to the Austrians, and the French naturally adopted all the means in their power to keep their projects secret, and deceive their foes. But there are always means of obtaining more or less of information under the most adverse circumstances; and I am the more disposed to insist here upon the necessity for a well organized department for the purpose, because movements may be made so much more rapidly by the aid of steam than by other means. The necessity for having such information at the earliest possible moment, increases in proportion to the rapidity with which an attack may be made, or a position gained. And as railways come more into use for military purposes, so should the "intelligence" department of an army be more carefully organized, and its functions be more efficiently performed.

It should be added, with reference to the strategy of the Emperor Napoleon, that a commander who is engaged in making rapid movements, and who is well informed with regard to the positions of the forces opposed to him, may fairly calculate upon immunity from attack in any particular direction, for a certain period after his plans have to some extent become developed; though it must be admitted that he had no right to reckon upon the Austrians being so much wanting in foresight, activity, or information, as they proved to be both during this flank movement and afterwards, in their dispositions previous to the battle of Magenta.

While, therefore, it would not often be desirable to follow the example of the Emperor of the French, in making so perilous a movement round the position of a powerful enemy advantageously situated, upon the chance of doing so unobserved and unopposed, it would be always inexpedient to follow the example of the Austrians, who left their opponents in free possession of an unobstructed railway almost surrounding their position, and allowed them to transfer the whole of their forces to a most important point, without taking proper measures for informing themselves in regard to their proceedings. They thus lost the most favourable opportunity that the campaign afforded, for striking a blow at their opponents, for gaining the prestige that they so much required, and for materially damaging the allies, without themselves incurring any serious risk in the operation.

The Austrians offered but very slight resistance at Novara when the allies entered that place, and they even abandoned the important masonry bridge at San Martino, over the Ticino, without destroying it. They mined the second pier from the right bank, with the intention of ruining the second and third arches; but the pier was not sufficiently injured to cause the fall of the arches, and the French were able to repair the bridge sufficiently for the passage of troops without difficulty. The Austrians were equally unsuccessful in regard to some of the bridges over the Grand Canal. They blew up the southernmost road bridge at Ponte Vecchio, and one arch of the northernmost bridge at Buffalora; but the latter was made passable for the allies by means of planks which had been carelessly left on the spot; and the more important bridge of Ponte Nuova for the main road, and the iron bridge which carried the railway, fell uninjured into their hands. But for the omission to thoroughly destroy these bridges, the French would still have found serious obstacles in the way of their advance, in the river as well as the canal, and time would have been afforded for the arrival of other Austrian corps.

In spite of these advantages, however, the French narrowly escaped a crushing defeat in the early part of the battle of Magenta. It will be remembered that the Emperor Napoleon had arranged to attack the Austrians in front, and to force a passage over the Grand Canal on that day, while Macmahon, moving southward from Turbigo on the east of the canal, should take them in flank. Having heard Macmahon's guns on the north of Magenta, he advanced with nine battalions of the grenadier division of the guard to attack the bridges over the canal, and gained two of them uninjured—the railway bridge and the Ponte Nuovo. But Macmahon, who had crossed at Turbigo, found unexpected obstacles and opposition to his advance from the north, over 10 or 12 miles, to the scene of the battle. The grenadier division of the guard, which crossed the canal without sufficient support, was well nigh overwhelmed, and Napoleon, under whose immediate directions it acted, was already bringing up artillery to endeavour to cover its retreat when Macmahon's force appeared in the distance. The Austrians this time brought up reinforcements by railway, which afforded them an opportunity for success in the early part of the day; but towards evening the Sardinians arrived in Macmahon's rear, the

French closed in upon the Austrians in increased numbers all round their position, and the Austrians were no longer in a condition to hold their ground. The railway served the Austrians on this occasion, not only as a means of reinforcement, but also as a means of defence. A letter published in the *Times*, writt en from Ponte di Magenta on June the 5th, to "My dear P.," said: "New and new battalions, "brought up by the railway, the whistle of which was heard, began "to advance to the attack of the position;" and the same correspondent added in a second letter, dated from Magenta on the 7th: "But the "fiercest fight was further behind, on the railway line and the station "house behind it, and the village close by. Pressed back all along "the line, the Austrians concentrated here all their efforts of re-"sistance. In front of the station, beyond the line of rails, is a "large long pit, extending for some distance to the right and left, "and formed by the excavations necessary for the construction of "the line. Besides this, the railway bank, which is somewhat raised, "forms a kind of ready parapet, behind which the defenders enjoyed "some protection. The station, as well as the neighbouring build-"ings, and a square, solid campanile, were filled with riflemen, "while the troops of the line massed themselves in front of them. "As the troops came up they were brought out here, and took the "place of their exhausted comrades. To carry this strong position, "the Fusiliers and Chasseurs of the Guard were ordered forward. "They broke through, driving the enemy before them, until their "course was arrested by the line of strong wooden railings. A few "common shot would have easily brought them down, but there was no "place whence to bring them to bear, so nothing remained but to "tear them down by main force and the axes of the sappers."

The Austrians abandoned Milan and retreated so hurriedly after the battle that they did not even destroy the railway or carry off the rolling stock. The Milanese sent a train to Magenta the next morning for the wounded, and the remainder of the wounded and the prisoners followed as speedily as they could be transported in other trains to that city.

The French owed, then, much of their advantage in this part of the campaign to the way in which they utilized the railways at their disposal.

In the first position they took up, from Casale to Voghera, they had, as we have seen, the great advantage of railway communication between the extremities of that position and with the fortress of Alessandria, which served as their base, near the middle of it. They were enabled, first to convey reinforcements by railway to Forey, when he was engaged at Montebello, on the east of that position; and afterwards to move rapidly northward, and by a circuitous route, towards Milan by the aid of the railway, with a secrecy, facility, and rapidity, that would otherwise have been impossible. And railway bridges gave them important assistance in crossing the various rivers and streams that they encountered.

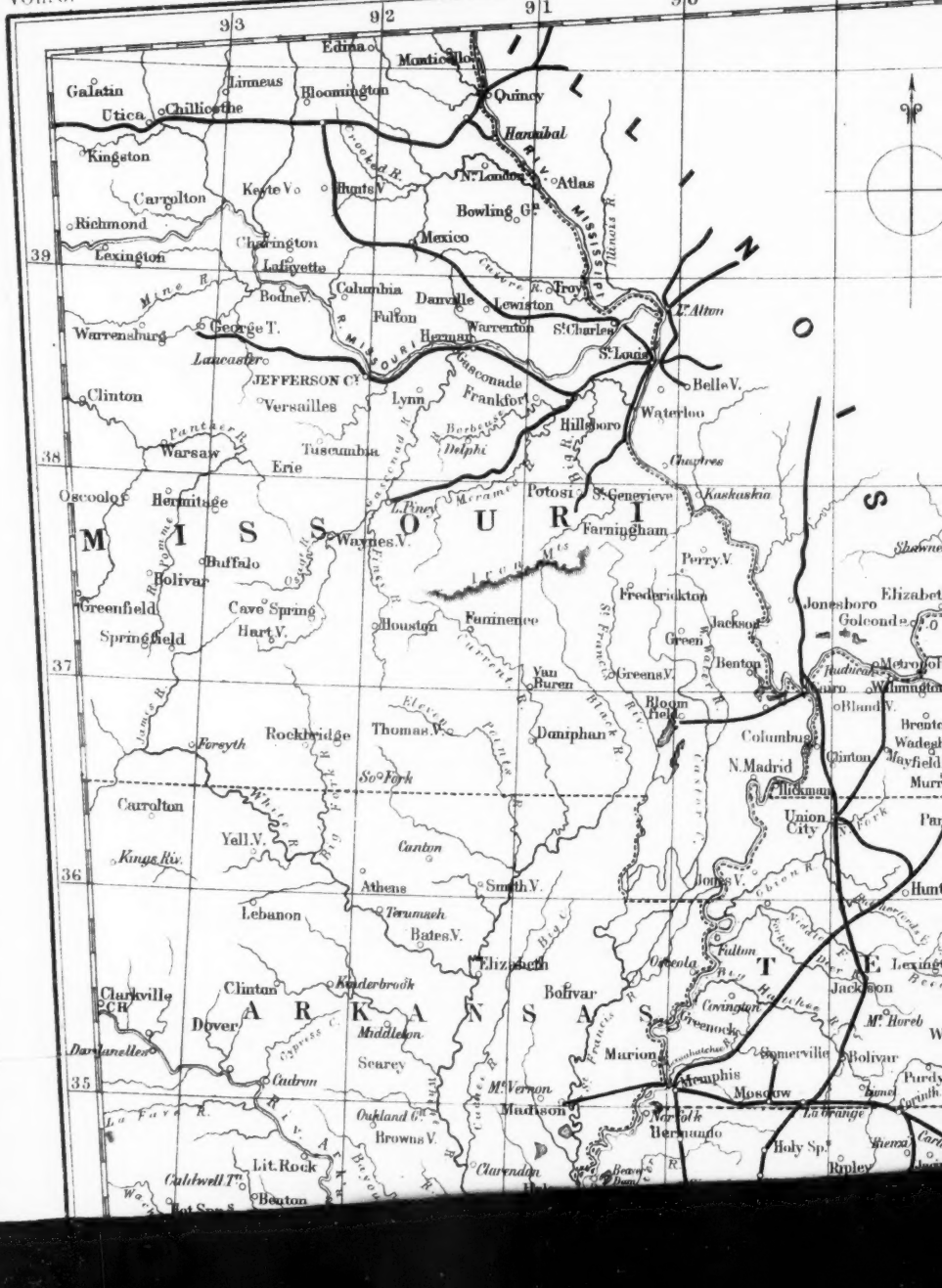
On the other hand, they would have found the route open from Novara to Milan, and would have been almost unopposed in crossing

the Ticino and the Naviglio Grande, if Count Clam Gallas had not arrived with his corps by railway in the opposite direction; and although the Austrians were surprised (in a military sense) by the rapid movements of the French, and were unprepared to meet them with the mass of their forces on the advance from Novara, the railway yet proved useful to them during the battle of Magenta. It enabled them to bring up reinforcements which they could not otherwise have received; and a railway embankment (which was subjected by General Auger to a flank and cross fire from 40 guns), served them for a breastwork, a railway *side*-cutting for rifle-pits, a railway fence for palisading, and a railway station for a block-house, at the most critical part of the fight. Their omission to destroy the railway to Milan after the battle, which afforded a good means of transport to the wounded, did them no great harm.

And here I would observe that, although failure to secure the destruction of railway bridges and works which may be of use to an enemy, as in the case of the bridge of St. Martino, is a serious fault, and may lead even to the failure of a campaign, yet a commander will always act wisely in abstaining from injury to a railway (as well as to any other work of public utility) which can afford no military advantage to an enemy. The importance of destroying such works depends, not upon the amount of damage that can be effected, but upon the means that are at hand for repairing it, and the time that can be afforded for doing so before they are required for use.

I need not follow the Austrians in their retreat behind the Mincio, nor the French in their cautious pursuit. Neither during these operations nor in the subsequent advance of the Austrians towards the Chiese, which led to the magnificent and hard-fought battle of Solferino, in which two Emperors and a King commanded their respective armies, were railways directly made use of, and therefore they do not present any incidents of interest connected with our present subject.

I now turn to another, and a very different theatre of war. The Italian campaign was concluded in two months, and the principal operations extended over a space of about 100 miles long, from Vercelli to Solferino, and 50 miles wide from Turbigo to Tortona. The civil war in America, which only now begins to show real symptoms of termination (from failure of confidence, and therefore of credit in the north), has lasted for three years, and has extended over an area some 900 miles long by 800 miles broad. The Italian theatre was traversed by numerous roads and substantial bridges, the destruction of which required more skill and powder than the Austrians had always at their command. But we have now to consider a country containing roads or tracks comparatively few in number, and often in very bad order —railways of great length, but cheaply constructed—numerous rivers spanned in many cases by wooden bridges and viaducts, which require no more than a lighted torch to ensure their destruction. The railways and rivers in America have been, in consequence of the distances to be traversed, and the indifferent character of the roads, of paramount importance in a military point of view; and the telegraph wire has partly superseded, for similar reasons, other means of transmitting orders, or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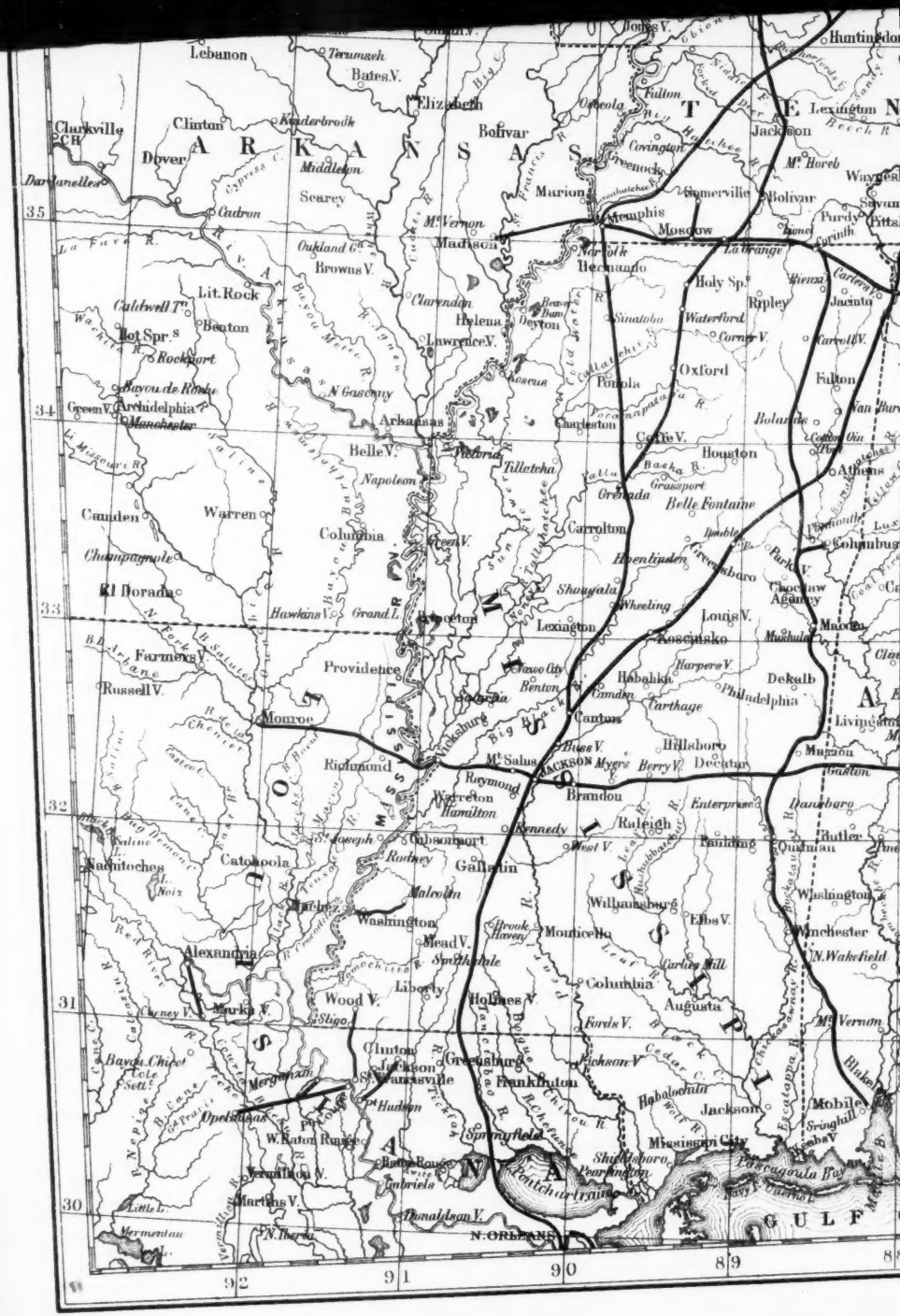
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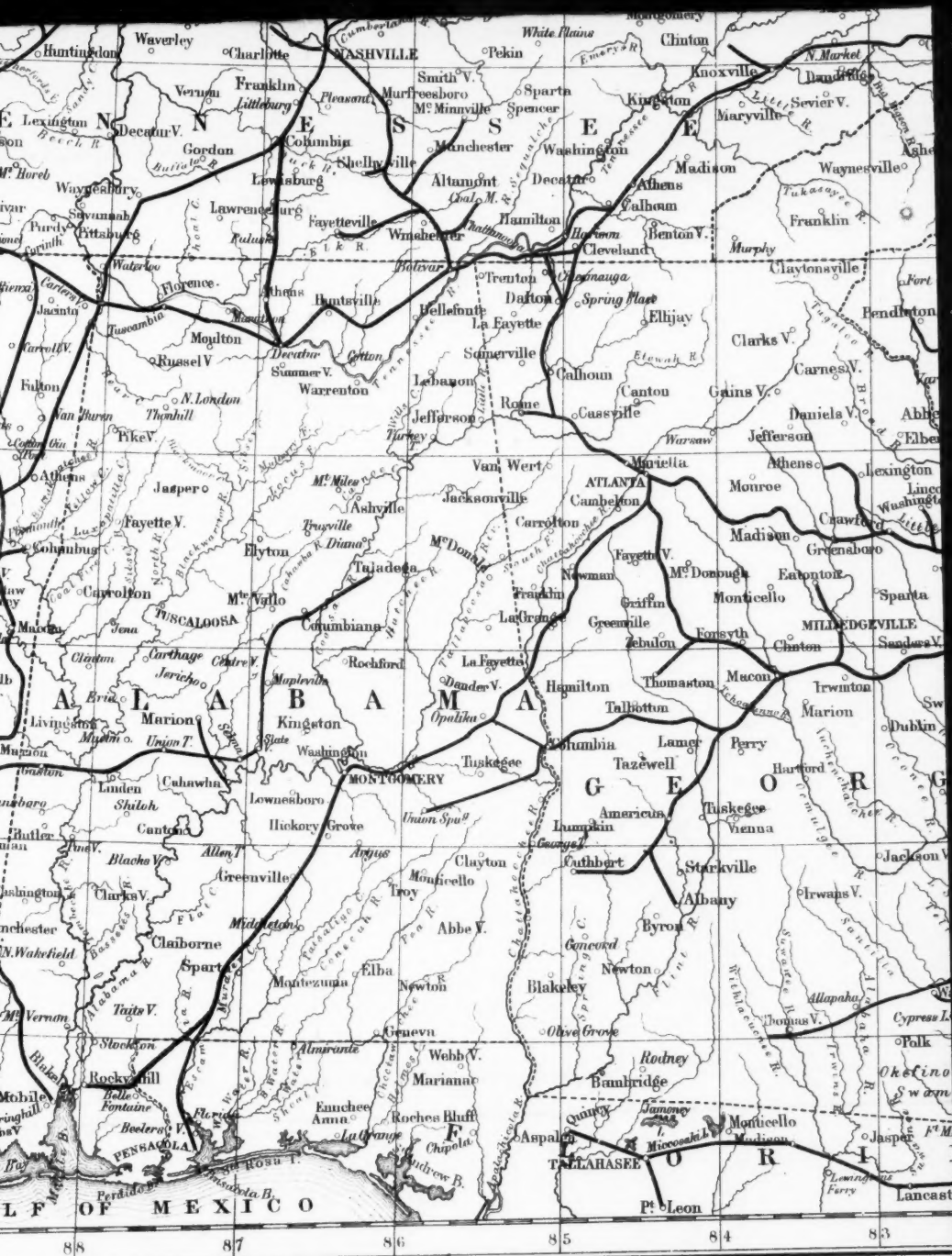
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Aucilla R.
Econfina R.
Choctawhatchee R.
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Pea R.
Escambia R.
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Shoal R.
Yellow Water R.
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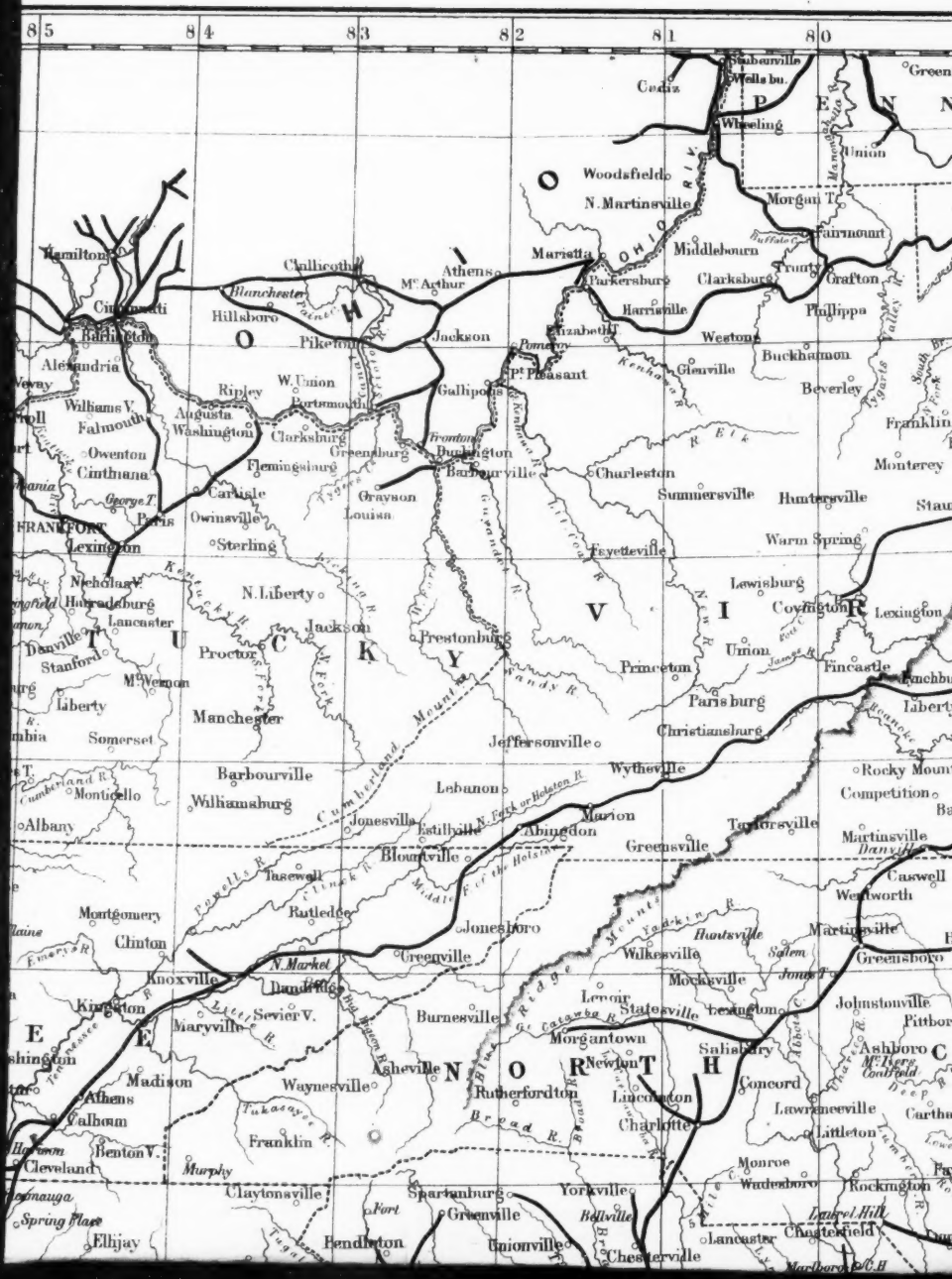
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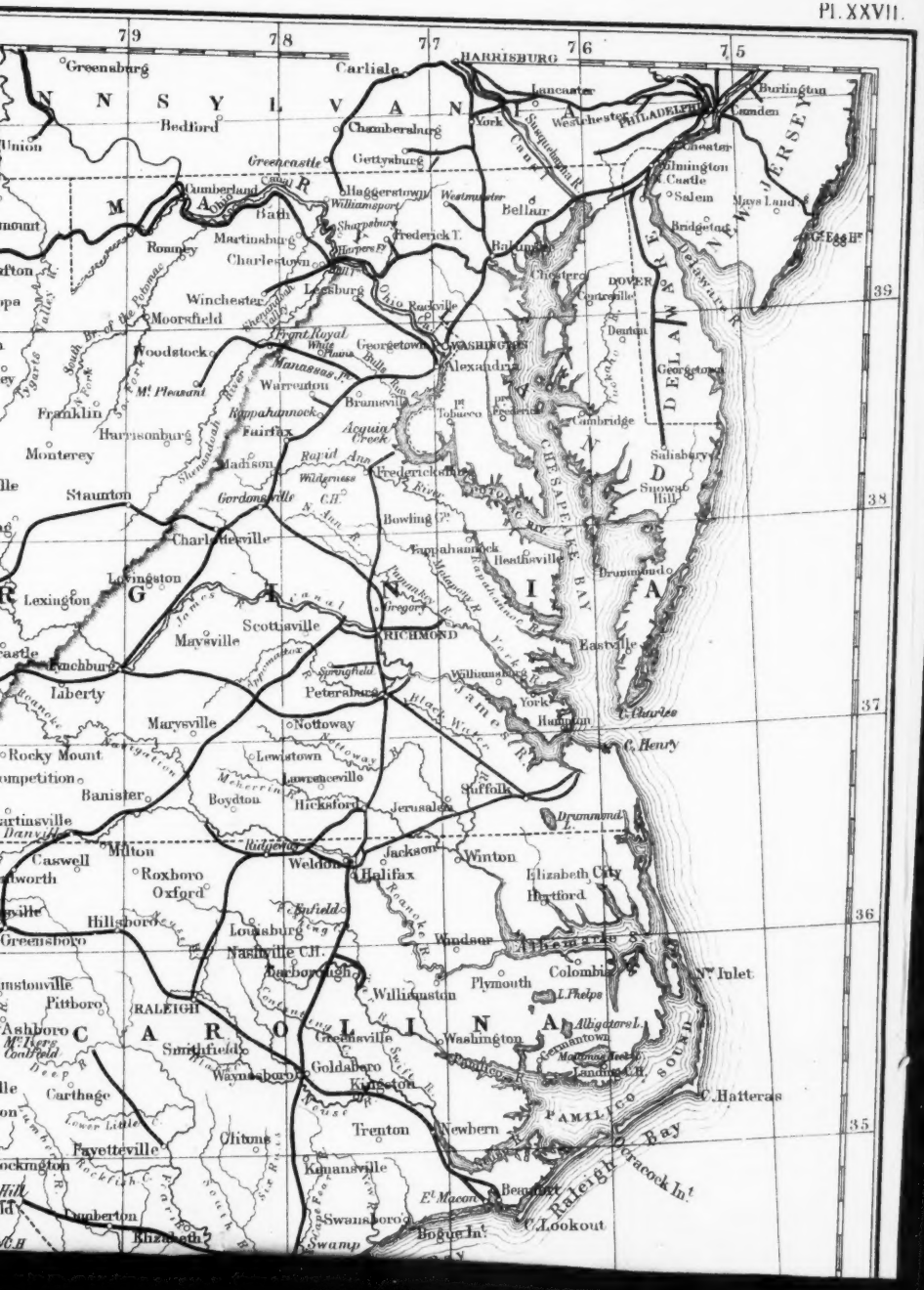
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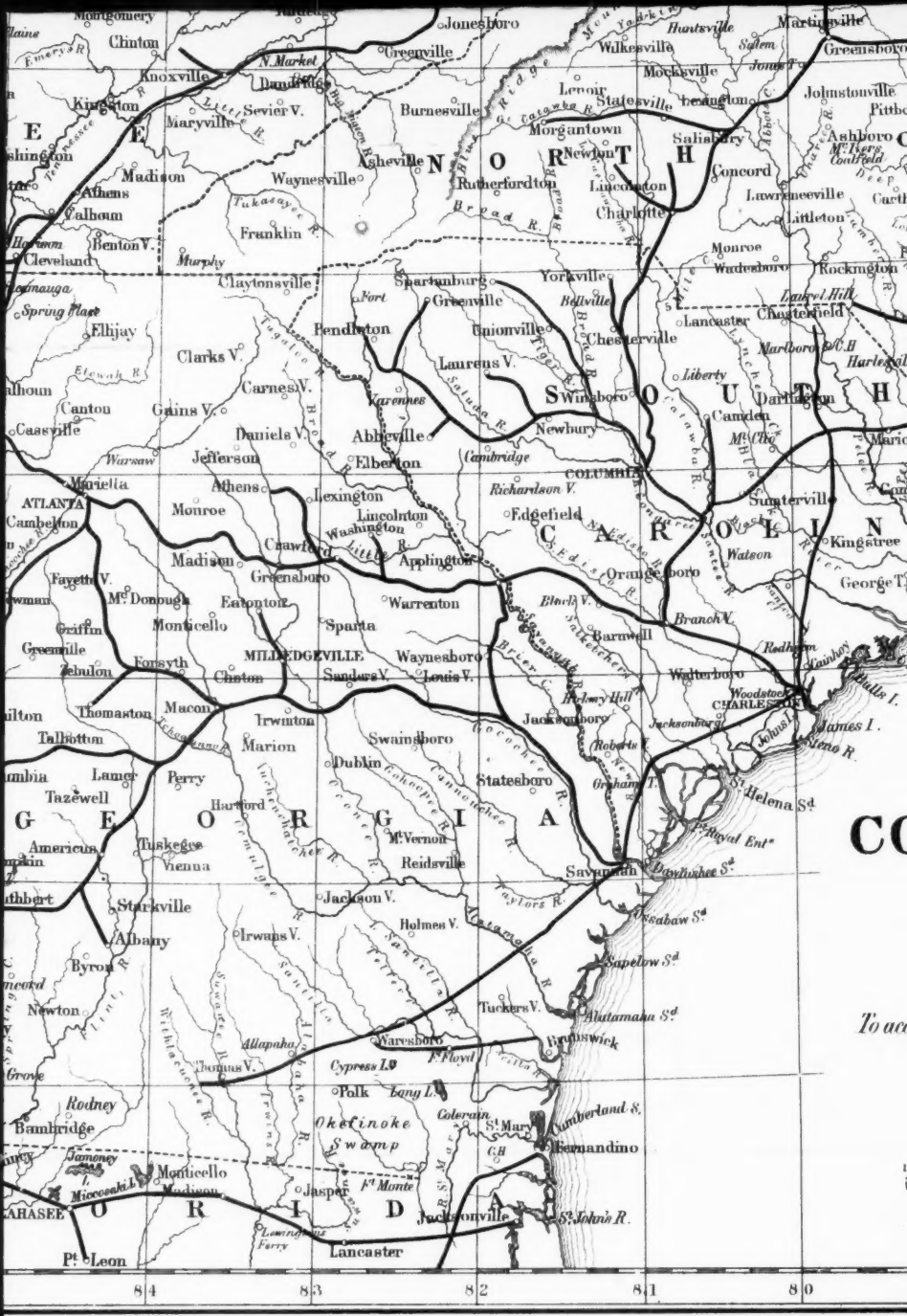
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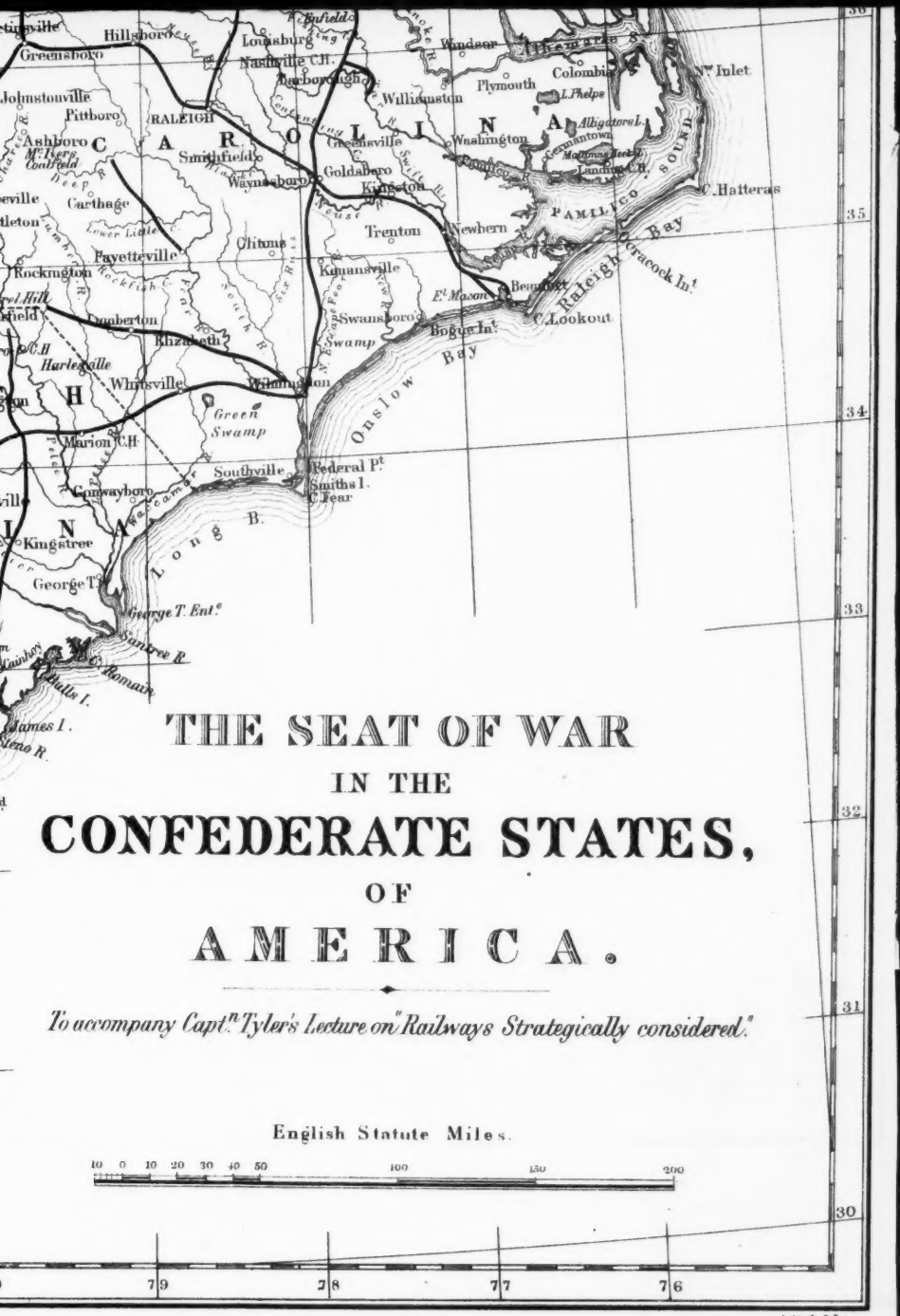

THE SEAT OF WAR
IN THE
CONFEDERATE STATES,
OF
AMERICA.

To accompany Capt.n Tyler's Lecture on "Railways Strategically considered."

English Statute Miles.

10 0 10 20 30 40 50 100 150 200

J.R. Jobbins.

of reporting from the different scenes of operations those results which have too often turned out to be either false or imaginary. The line of railway is there in many cases the only practicable means of communication and transport, for moving an army as well as for supplying it with provisions, stores, ammunition, and reinforcements, and it becomes itself a primary object of attack. Expeditions are organised, or raids undertaken, for tearing up rails, for burning wooden sleepers and timber beams, for capturing or destroying engines, carriages, and trucks, and for rendering a railway temporarily useless. Battles are fought for the possession of a junction between two or more railways, and these junctions become strategical positions of the first importance.

The main objects of the Northerners are of course (1) to take possession of the Southern capital so near to them at Richmond; (2) to secure the navigation of the Mississippi and other rivers; (3) efficiently to blockade the southern ports, and (4) to seize important posts on the coast and inland, with a view to the subjugation of the seceded states. The objects of the Southerners, on the other hand, are strictly defensive, and their operations are therefore mainly confined to active resistance at the several points of attack, with a view to ultimate freedom from Northern domination.

Taking a general survey of the scene of operations, the points to which I would now particularly direct attention upon the map* are, (1) the two capitals—Washington and Richmond, shown by dark marks, within 100 miles of one another; (2) the Ohio and Mississippi rivers, forming one continuous river line 1,200 or 1,500 miles long, from Pennsylvania to New Orleans, with the Cumberland, the Tennessee, and its other tributaries shown in blue; (3) the Potomac, the Rappahannock, the York river, and the James river, in the vicinity of Washington and Richmond, also in blue; (4) the railways (shown in brown) of greatest importance for strategic purposes, comprising—the route along the Potomac from Washington to Cumberland and Cincinnati—the main route from Washington and Richmond on the east to Memphis on the Mississippi—the north and south routes from Memphis by Jackson, Mississippi, to New Orleans, and from Columbus by Corinth to Mobile—the line from Louisville to Memphis crossed by the through route, past Nashville and Chattanooga, to Atlanta and the whole of the south-eastern states—the three communications with Richmond, (*a*) from Washington by Gordonsville on the north and west; (*b*) from Aquia Creek and Fredricksburgh on the north; (*c*) by the York river railroad on the east.

In consequence of the want of rails for renewals, and of sufficient engines and other rolling stock, the Southerners appear, in spite of their possessing this system of railways, to have laboured under very serious difficulties of transport, and they have at times been hardly able to furnish supplies for their armies. Without these railways, they could not possibly have carried on the war on the same scale, or with the same success. The railways have indeed been their principal allies;

* Vide Plate xxvii.

they form the key by which the object of almost all their inland operations may be understood; and their course has served to determine the site of almost all their positions; while the lines of the great rivers, on the other hand, have necessarily been followed by the Northerners in their aggressive operations. No great northern army has been able to maintain itself for any length of time, even with the aid of railways, more than a day's march from the sea or from a great river, and no great Confederate army has been able to remain or can remain far away from a line of railway. Over and over again they have been unable, without railway communication close at hand, either to continue a battle or to follow up a victory, for want of ammunition, which their other means of transport does not enable them to carry in sufficient quantity.

In the short time here allotted to me, I can only dwell briefly upon portions of some of the operations that have been carried on over this vast area, and over this lengthened period. I have selected a few examples that may best show the mode in which railways have been employed, and thus illustrate my subject. I shall have occasion to give some extracts from American newspapers, but I cannot feel that they are by any means reliable sources of information. Many of the reports on military and naval subjects are mere fiction, and are no more to be believed than the story of a dog and his tail, which appeared in the advertisement of a New York paper not long since, about the same time that the celebrated Report by the Secretary of the Confederate Navy, which so completely deceived us on this side of the water, was published in New York.

The different campaigns in Virginia, which first claim our attention, commenced in struggles for the possession of railway junctions, and the last important movement was principally for the purpose of destroying the Orange and Alexandria railway.

M'Clellan's successful action at Grafton, the junction of the railway between Cincinnati, Harper's Ferry, and Washington, with the railway to Wheeling, was almost the first operation of the war; and his seizure of that important place was the means of obtaining further success at Beverley and Huttonsville, and of driving the Southerners out of western Virginia.

The still more important point of Harper's Ferry, where the Shenandoah river joins the Potomac, where the railway from Winchester (the capital of the Shenandoah valley) joins the main line to Cincinnati and Washington, and where the eastern ridge of the Blue Mountains falls towards the river, was held by the Confederates until the middle of June, 1861, when the Northerners advanced in overwhelming numbers to occupy it. It afterwards became famous in consequence of the capture of Federal troops and stores effected there by Stonewall Jackson, under Lee, on his first invasion of Maryland.

The next place to which I would refer, is the Manassas junction, at which the railway from the Shenandoah valley and Front Royal joins the main line from Washington and Richmond on the east to Memphis on the Mississipi. Of the two pitched battles (of Bull Run) which have been fought near this place, the first took place on the 21st July,

1861. After retiring from Centreville on the 18th July, Beauregard posted his (Southern) forces on the north of the junction; and M'Dowell "concluded" to cross two fords over the Bull Run stream with the mass of the Northerners, in order to turn the enemy's left, and to destroy the railway on the west of the junction. Beauregard reinforced his left wing; Southern reinforcements, arriving by railway, left the train before it arrived at the station, and attacked the right and rear of the Northerners; and the Northerners, unable to stand such an attack, or to rally after it, fled in disorder.

The Northerners advanced to the attack on this occasion to the tune of Yankee Doodle, hardly calculated, perhaps, to inspire them with much martial ardour; and the Southeners, who are endowed with a lively wit, and have composed several songs to that tune in the course of the war, described the fight and its results in the *Richmond Whig*, in a piece of poetry which is too long to give here and is not fitted to so select an audience, but in which occurs the lines—

> "Yankee-doodle wheeled about,
> "And scampered off at full run,
> "And such a race was never seen,
> "As that he made at Bull Run."

The second battle of Bull Run, on the 29th and 30th August, 1862, which also ended in favour of the Confederates, was fought between Jackson with 30,000 men on the first day, and Jackson and Longstreet, under Lee, with 45,000 men on the second day, against Pope at the head of 60,000 men. The positions of the contending armies were almost reversed on this occasion. Pope had advanced, in compliance with orders from Washington, towards the Gordonsville junction, in order, by threatening that junction (between the railways from Washington and Richmond, to Staunton and the Mississippi), to draw off attention from M'Clellan, and to allow of his army being extricated from its disastrous position on the peninsula east of Richmond.

In their several advances towards Richmond, the Federals have hitherto adopted the lines laid down for them by the railways. On the map, the route through Fredericksburg appears at first sight the most inviting, because the railroad through that place is nearly in a straight line in continuation of the Potomac, and is connected with a most convenient water-base at Aquia Creek, immediately to the south of Washington; but the difficulties by that route have hitherto proved to be insuperable. And, indeed, a railroad 65 miles long, as a sole means of communication with the base of operations, is too precarious to be relied upon in a hostile country for the continued supply of a very large army. Supposing that a large Federal army could, after safely crossing the Rappahannock, and after gaining instead of losing battles near Chancellorsville or Fredericksburg, be advanced by this line to some point near Richmond, its commander must then either leave a considerable part of his force to guard the line of railway, or run the risk of having the railway destroyed in his rear, and of being thus cut off from the means of either supply or retreat. Under these

circumstances, and because the route by Gordonsville offered still further difficulties of the same description, M'Clellan determined early in 1862, to advance along the peninsula from the east, so as to obtain the advantage of water communication to within a shorter distance of the southern capital.

When he reached the White House he had the advantage of the York River railroad, only 35 miles long, to communicate with the enormous depôt which he had formed on the Pamunkey River. He repaired the railway without difficulty, and employed it for the supply of his army, but he required considerable detachments to guard it, and could not, even then, do so effectually. The Confederate cavalry, under Stuart, made a circuit round his rear, set fire to two of his transports, fed upon his provisions; and, disappointed of support from M'Dowell, who had been recalled to protect Washington in consequence of Jackson's exploits in the Shennandoah Valley, he was glad enough to escape, after the seven days' fighting on the Chickahominy, to Turkey Bend, and to seek refuge under the fire of his gunboats, on the banks of the James River.

But it was the sudden and unexpected return of Jackson by railway from Staunton, at the head of the Shenandoah, that contributed more than anything to the dismay of the Federals and the defeat of M'Clellan on this occasion. And the combination of marching and railroad travelling effected by Jackson, in first defeating the different armies opposed to him, at considerable distances from his railway-base at Staunton,—and then, after alarming the Federal authorities for the safety of Washington itself, returning by a rapid railway journey, to attack the right flank of the main army of the Federals before Richmond, when he was thought by them to be still in the north, is, perhaps, the most interesting and instructing episode in the whole war. It afforded the lessons that the Federals most required to learn, and that we may all study with benefit, in showing that whatever advantages may be possessed of railroad communication, the best opportunities must still remain with those forces which are prepared to march rapidly, as well as to travel by train when the occasion requires—that an army must not, because railway facilities are at hand, be unnecessarily encumbered with extra stores and baggage—that, in fact, locomotives must not supersede legs, and must not be made an excuse for useless encumbrances.

These operations afford, also, a valuable example of the advantage of even partial railway assistance in defensive warfare, and on interior lines, and of the minor use that can be made of them in aggressive warfare, in an enemy's country.

The last considerable operation that took place in these quarters, was when Lee, crossing the Rapidan in October last, pushed the invading army of Meade back upon the defences of Washington, by suddenly threatening his communications along the Orange railway. It was at first supposed by the Federals that the Confederates intended on that occasion to make another raid into Pennsylvania; but the event proved that their principal objects were, partly to take any opportunity that offered of advantageously engaging the Federal army,

and to seize what prisoners and booty they could from that army; but especially by destroying the railroad itself, to prevent the possibility of a further advance in that direction for some time to come, and perhaps for the remainder of the year. Those objects were fully attained. Meade saved, indeed, the bulk of his army from any great disaster, by a timely and active retreat. But he is said to have lost 7,000 prisoners and a vast quantity of material in doing so. A correspondent of the *New York Times* said, "The desperate dashes which "they made at our trains, show, too, how greedy they are for booty;" and, he added, with regard to the Orange Railroad, 24 miles of which were destroyed on this occasion;—"This work has been very thoroughly "done, Lee's whole army having been engaged on it for two days. "From Bristol to the Rappahannock the destruction is complete— "bridges burnt, culverts blown up, ties taken up and burnt, rails "twisted and rendered useless, cuts filled up, &c. The engineers say "that it will be at least a month before it can be again put in running "order. It is with no small mortification, therefore, that we have to "confess the rebels have achieved an end fully commensurate with "the labour and risk of the campaign."

It will be an interesting study to compute at the end of the war, how many times different portions of railway have been destroyed and renewed, what proportions of construction and destruction have been effected by the Federals and Confederates respectively, and how many miles of new railway might have been constructed with the labour, money, and materials, that have been so freely lavished in these operations. Regular conspiracies were deliberately formed in some states for the destruction of railroad works and bridges; and, it has frequently occurred, as the lines of operation varied, that each side was glad to make use of portions of railway which they destroyed at other times, when they were likely to be of advantage to the enemy. I may here refer to some of the instances in which railway works have been destroyed, as showing the precarious character of railway communication, especially when timber bridges and viaducts are employed.

During the riots at Baltimore at the commencement of the war, the mob destroyed the station and burnt the bridge over the Susquehanna, as soon as the troops had started in the trains for Washington.

When the Confederates evacuated Harper's Ferry in June 1861, they destroyed, says Colonel Estran, "that wonderfully constructed "railway bridge which here spans the broad stream of the Potomac." At a given signal this structure was blown into the air with a terrific explosion. All the buildings connected with it, the station, engines, locomotives, warehouses, as well as a flourishing town, with all its trade and prosperity, were condemned to destruction.

Colonel Estran also relates how that when the Confederates evacuated Newbern, about February 1862, they retreated across the "fine railway bridge which here spans the river Reuss;" and he adds: "The Federal troops now delivered so deadly a fire that our troops "were driven from their positions, and we had to cross the bridge, to "which we set fire immediately after, in order to prevent its falling "into the hands of the enemy. In a few moments dense columns of

"smoke denoted that this work of destruction was in progress. Whilst "this noble bridge, the pride of the people of North Carolina, was "thus becoming a prey to the flames, the enemy actually stopped "firing, to witness the grand and awful spectacle. The flames rapidly "increased, the timbers crackled, and the whole structure finally fell "with a tremendous crash into the river below, and then for a brief "interval all was still again." It appears that "General Branch, who "commanded the Confederates, had previously secured a railway "carriage to himself, and started off inland," and that he afterwards (as it is quaintly stated) "found it no easy task to re-establish his "reputation for bravery."

When John Morgan, the Guerilla leader, made a raid on the small town of Gallatin, 20 miles north of Nashville, then occupied by the enemy, he proceeded to the railway station, and on the arrival of the train took prisoners the engine driver and five officers who were in it. "He then had all the carriages set fire to, and covering the engine "with turpentine, tow, and other inflammable matter, he sent it back "on fire at full speed towards Nashville."

It is stated in the *New York World* of June 15th, 1861, that "Some "disunion troops from Leesburg, Virginia, burnt four bridges on the "Alexandria, London, and Hampshire Railroad, at Tuscarora, Lycoline, "Goose Creek, and Beaver Dams, being the balance of the bridges "from Leesburg to Broad Run." On November 9th, two road bridges on the Georgia State road, two on the Chicamauga Creek and Hamilton County, three on the Eastern Tennessee and Georgia road, were all burned by the Union men of East Tennessee. On November 13, one bridge 200 feet span, four bridges north of Knoxville, and one very heavy bridge at Charleston, 75 miles south-west of Knoxville, were also burned.

The *St. Louis Democrat* of October 17th gives also a circumstantial account of the burning of the Big River Bridge—the principal bridge on the Iron Mountain Railroad. It appears that the 40 or 50 men who had been stationed in the neighbourhood to guard it were overpowered. A railroad train, which arrived about this time, was sent back for reinforcements. But they arrived too late—to find the timbers burning, the rails torn up on each side of the bridge, and the telegraph wires clipped.

But the horrible system which was adopted, of half burning the bridges with a view to the trains "falling through," affords stronger instances of the disadvantage of travelling by railway through a hostile country.

On the 3rd September, 1862, the Secessionists of Missouri burned several of the bridges on the Hannibal and St. Joseph Railroad; and on a train with nearly 100 passengers coming up to the Little Platt river, the bridge gave way, and precipitated the whole train down an embankment with terrible slaughter. And the *Louisville Journal* of September 13th, 1862, says: "Another fiendish attempt to destroy the "lives of national soldiers was made a day or two since on the North "Missouri Railroad. The timbers of a bridge near Sturgeon were "partially burned, in expectation that a train loaded with troops would

" be precipitated into the creek below, but the design of the villains " being known, the train stopped at Mexico, *and the troops encamped* " *at that place*, where they *remained until the bridge was repaired.*"

The campaigns of Tennessee and the West have not been reported to us so much in detail as those in Virginia. Northern misrepresentation and Southern reserve have united to envelope many parts of them in mystery. But they are not less interesting, and certainly they redound far more to the credit of the Northerners. As soon as time had been afforded for the necessary preparations, the Federals possessed great advantages in being able to place gun-boats upon the Mississippi, and Tennessee, and other rivers, and by their communications by railway from all parts of the Northern States; and Cairo was soon occupied by the Federals. But Lexington on the Missouri was taken, with its stores and money, by the Confederate General Price. A series of advances, retreats, and conflicts was followed by a struggle for the possession of the unfinished railway from St. Louis to Memphis. At length the Federals prepared a joint expedition of troops and gunboats, with which to take advantage of the rivers of the country. The Southerners held Columbus on the Mississippi as late as January, 1862, and made a stand for some time at Bowling-green, where the railroad from Louisville to Memphis joins the railroad southward to Nashville. But on the 6th February, 1862, Fort Henry, a small work on the Tennessee, was captured. Bowling-green was evacuated on the 15th February; and Fort Donnelson, an important work on the Cumberland river, and on the Memphis and Louisville railroad, surrendered with 12,000 prisoners and great quantities of artillery and stores to General Grant and Commodore Foote the next day. This was a terrible and unexpected blow to the Southerners. Nashville, an important railroad junction, their base of operations in this direction, the capital of Tennessee, and containing vast quantities of specie, ammunition, and stores, became untenable, no preparations having been made for so unforeseen an event. The Confederates destroyed as far as possible their gunboats, provisions, and such valuables as they could not remove, and then occupied Jackson, Tennessee, and afterwards Corinth; and they retained that junction between the Memphis and Charleston railroad and the south line to Mobile for a considerable period. Beauregard's head-quarters were at Jackson in March, 1862. On the 3rd April General Sidney Johnson issued an address at Corinth to the (Southern) army of the Mississippi, of which Beauregard was second in command; and on the 6th and 7th April they turned upon the Federals at Pittsburg, and fought that desperate battle which has been styled by the former the battle of Pittsburg Landing, and by the latter the Victory of Shiloh.

During these operations the Confederates clung to the railways by Jackson Tenn, on the west, and by Murfreesborough, south of Nashville, the scene of other important engagements, on the east; and they made important use of these railways, as appears from Beauregard's report, to concentrate their forces for the fight at Pittsburg. The Federals on the other hand employed the Tennessee river in their advance, and it was their approach by that river to the Memphis and

Charleston railroad that induced Beauregard to attack them at Pittsburgh. But the Confederates were at length driven back all along their line to the important through line of railroad already referred to as joining the prolongation of the Orange and Alexandria railroad, and thus connecting Washington and Richmond with the Mississippi. This through line has been employed, it will be remembered, to great advantage by the Confederates in transferring troops from Virginia to Tennessee, and *vice versâ*, over a distance of about 500 miles, and notably on the occasion of the battle of Chicamauga, which was won by the sudden appearance of Longstreet and his troops from Virginia. This line is now held by the Federals at Chattanooga and Knoxville, at both of which places it joins the Tennessee river. The position of Chattanooga I would advert to as being a particularly important one, as will be seen by a glance at the map. Besides being situated on the Tennessee river, it is the point on which all the railway communications of this region converges, from Washington and Richmond on the east, from the whole south-east by Atlanta, from Memphis on the west, and from the whole north and west by Nashville and Louisville. But this position, however valuable to hold, is by no means an easy one for the Federals to advance from, as long as the Confederates are able to maintain a sufficient force in their front, because they would leave the river behind them, and be obliged to trust to railway communication, which is already liable to interruption between Chattanooga and Nashville, and which would be still more so as they approached Rome and Atlanta.

To show the feelings of the Northerners when they reached the Memphis and Charleston railroad, and as an example of the advance of a body of Northerners in an exceptional way, I would quote the following in regard to the march upon, and capture of, Huntsville, on the 11th April, 1862. A correspondent of the *Cincinnati Gazette* says, April 11, 1862:—"We have achieved a victory which, although bloodless, must be attended by such important results as can hardly be over-estimated. The main line, and for all practical military purposes the *only* line of communication between the eastern and western armies of the enemy, is in our hands. To General Mitchell and his brave troops belongs the distinguished honour of being the first to penetrate to the great Charleston and Memphis railroad, and the first to break the rebels boasted line of defence, extending from Chattanooga to Corinth.

"We all perfectly understand, too, that the rebels had accumulated upon this road nearly all the rolling stock of all the railroads from Bowling-green southward, besides what legitimately belonged to the road itself; and that they could therefore concentrate at any threatened point whatever forces they had at command.

"An advance force of a hundred and fifty cavalry, together with a section of the battery in charge of Captain Simonson himself, assisted by Lieut. M. Allen, commanding the section, the whole directed by Colonel Kennet, first caught sight of Huntsville, and the lovely cedars surrounding it. They were advancing upon the double quick, when two locomotives, with trains attached, suddenly made their appearance upon the railroad. They were moving in the direction

"of Stevenson. A shot from one of Simonson's guns brought the "first one to. The captain then turned to pay his respects to the "second. A shot or two induced it also to haul up. In the meantime "the engineer of the first train was quietly getting on a full head of "steam, and when nobody was suspecting such a thing, he suddenly "started off. The cavalry went in pursuit, and actually chased the "locomotive for a distance of ten miles.

"A few horsemen tried their carbines upon the second train, and an "unfortunate coloured person received one of the bullets in his neck. "It was said too by the secesh that a rebel from Corinth, going home "slightly wounded, was instantly killed.

"The infantry had come up while this was going on, and Colonel "Mihalotzi, of the twenty-fourth Illinois, sent a detachment to tear "up a portion of the track in the direction of Decatur. The escape of "any more trains was thus effectually prevented."

And Brigadier-General O. M. Mitchell says, in a General Order (No. 93), dated "Head-Quarters, Third Division,

"Camp Taylor, Huntsville, April 16, 1862.

"Soldiers,—Your march upon Bowling-green won the thanks and "confidence of our Commanding-General. With engines and cars "captured from the enemy, our advance guard precipitated itself upon "Nashville. It was now made your duty to seize and destroy the "Memphis and Charleston Railway, the great military road of the "enemy. With a supply train only sufficient to feed you at a distance "of two days' march from your depôt, you undertook the herculean "task of rebuilding twelve hundred feet of heavy bridging, which by "your untiring energy was accomplished in ten days.

"Thus, by a railway of your own construction, your depôt of sup-"plies was removed from Nashville to Shelbyville, nearly sixty miles, "in the direction of the object of your attack. The blow now became "practicable. Marching with a celerity such as to outstrip any mes-"senger who might have attempted to announce your coming, you "fell upon Huntsville, taking your enemy completely by surprise, and "capturing not only his great military road, but all his machine-shops, "engines, and rolling stock.

"Thus providing yourselves with ample transportation, you have "struck blow after blow with a rapidity unparalleled. Stevenson fell, "sixty miles to the east of Huntsville. Decatur and Tuscumbia have "been in like manner seized, and are now occupied. In three days you "have extended your front of operations more than one hundred and "twenty miles, and your warning gun at Tuscumbia may now be "heard by your comrades on the battle-field made glorious by their "victory before Corinth.

"A communication of these facts to head-quarters has not only won "the thanks of our Commanding-General, but those of the Depart-"ment of War, which I announce to you with proud satisfaction.

"Accept the thanks of your Commander, and let your future deeds "demonstrate that you can surpass yourselves. By order of

"O. M. Mitchel,

"W. P. Prentice, A.A.G." "Brigadier-General, Commanding."

This force moved from Bowling-green to Nashville and Shelbyville, about 140 miles, by railway, and afterwards marched about forty miles to Huntsville. They did not acquire much glory in marching upon Bowling-green, or in precipitating themselves upon Nashville, because those places had previously been evacuated by the enemy. But they performed so great a feat in construction, by building 1,200 feet of heavy bridging in ten days, that I must leave the statement to the credibility of the Brigadier-General. They captured 17 locomotives and 150 cars at Huntsville.

I need not further refer to the fighting on the Mississippi, except in one particular. I would point out that the entrenched position of Vicksburg, which formed the principal defence of the Confederates upon that river, and which was so long and so gallantly maintained by them, existed as a military post in consequence of the communication by railway which it possessed with the country east and south of it. Its garrison resisted all bombardments and assaults by sea and land as long as that means of communication remained open, and only fell for want of supplies after it had been closed. Without that key to solve the problem, it would not be possible to understand the operations which led to its capture. The Federal General Grant obtained success last year, not by a direct attack upon it, but by marching from Grand Gulf, 20 miles south of it, to Jackson, 50 miles east of it. The possession of the latter place—at which the north and south railroad from Columbus to New Orleans joins the railroad running eastward from Vicksburg to Selma—enabled him to prevent all approach to it, to cut off all chance of supply, and thus to render it untenable.

The general lessons which may, as it appears to me, be deduced from what is at present known on the subject, are that: (1.) Railways may, when available, be often used with great advantage on a theatre of war, as an auxilliary means of moving troops, and as a principal means of supplying them. (2.) Railways are more quickly and easily destroyed and more readily repaired (in a temporary manner) when the necessary materials are at hand than common roads. (3.) A single line of railway, in good order, and furnished with a proper proportion of sidings, crossing-places, and rolling stock, is sufficient for the ordinary supply of any army in the field. (4.) Railways constructed with a view to strategical purposes, and intended for the conveyance of troops, should be laid with a double line of rails. (5.) A commander should in no case rely altogether upon a railway for communication with his base of operations in a hostile country, and should not rely too much upon a long line of railway, subject to attack from an enemy, in any country. (6.) Railways may be employed to much greater advantage in defensive than in offensive warfare. (7.) Railway junctions will often become strategical positions of the greatest importance. It is further plain, that as railways increase in number, and come into common use in military operations, so it will become more desirable that every soldier in an army should be able to assist in destroying or repairing them. I have had occasion to point out in

previous lectures* that the use of the spade in warfare will necessarily increase with the common employment of, and with a growing proficiency in the use of, rifled weapons; and I would now add that the use of railways in war will render it still more desirable that every soldier should be trained to be more or less of an engineer.

The best mode of imparting such training to British soldiers will be—not merely by putting them through an appropriate course of instruction—but by also employing them, or allowing them to work under proper restrictions, at trades and on works of public utility.

The day has gone by when a soldier's efficiency was supposed to depend more on the stiffness of his stock than upon his power to hit an enemy. A well trained, or an educated man, is not now considered likely to make a worse soldier than an ignorant boor. A commencement has been made under our enlightened Commander-in-chief with great success at Portland and Dover, in employing British soldiers, as those of other nations are employed, upon public works, and I hope that we may see that system very much extended. The soldier will become a more useful member of society, will be enabled to increase his means of subsistence, and will be materially raised in the social scale. Drill, discipline, and shooting, which are the first considerations in a military point of view, will not be less well learnt, or less remembered; temptations to strong drink and vicious habits, which are the result of a want of sufficient occupation, will in a great measure be removed; practice in actual work at home will make him more active, more handy, and more ready to perform any duties that may be required of him abroad or in the field; and he will be better able to provide for himself, and less dependent upon others, when his term of military service is completed.

* *Vide* lectures on "The Rifle and the Spade," 1st April, 1859; and "the Effect of the Modern Rifle upon Siege Operations," 16th April, 1858, at the Royal United Service Institution.